POWER PLANT ENGINEERING

GENERATION, TRANSMISSION AND UTILIZATION OF STEAM, ELECTRIC, DIESEL AND HYDRAULIC POWER

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Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index on file in Public Libraries.

JUNE
1939

Vol. XLIII., No. 6

Published on the first of each month, copyright 1938 by the
Technical Publishing Co., 53 W. Jackson Blvd., Chicago.
New York Office, 171 Madison Ave.

EDITORIAL STAFF: ARTHUR L. RICE, Editorial Director R. E. TURNER, Editor.
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Subscription price. U. S. A. $2.00 a year; other countries, $3.50 a year. Single copy current issue, 25c; other countries, 35c. January issue, U. S. A., 50c; other countries, 60c. Back issues, single copy, U. S. A., 40c; other countries, 50c. January issue, U. S. A., 75c; other countries, 85c.

Member, Associated Business Papers, Audit Bureau of Circulations.

ANNOUNCING

THE PRACTICAL ENGINEER

A Brand New Feature Devoted to OPERATION and MAINTENANCE

YOU, like every engineer, are seeking to get the best economy from your plant. This may involve such rehabilitation or renewal as will remove obsolete and inefficient equipment, and certainly involves keeping all equipment in condition for best performance and avoidance of shut downs. Maintenance must be systematized and regularly carried out.

Even with the best of equipment and maintenance, unless your operation is intelligently planned and results checked, best economy will not be secured.

Once a plant is installed, which is the field of the designer and constructor, correct maintenance and operation are the requisites to produce and utilize power at least cost. These features are the province of every plant executive and operator.

Understanding of the proper technical and scientific basis of power production is as essential to good operation and maintenance as it is to design and installation, but actual application of this knowledge requires ingenuity, experience and resourcefulness to be gained only by long service in the field and by study of the work of others. Realizing the importance of these factors, POWER PLANT ENGINEERING has been planning and arranging, for many months, to incorporate a feature "THE PRACTICAL ENGINEER," which will deal with operation and maintenance as involved in your daily work, where experiences and opinions may be exchanged by readers, problems presented for solution, methods of operation and maintenance discussed and kinks and short cuts recorded. The July issue will inaugurate this feature.

To add to the interest, a problem will be presented each month for solution by readers and, for the best solution, a cash prize will be awarded, with a set of power plant manuals for the second best solution.

Each problem will involve some phase of plant design, operation or maintenance, such as might be encountered in any plant and might be solved in a number of ways. Actual experience in solving such a problem is not necessary. The question will be, "What would you do in this situation?"

Besides the problem contest, you are invited to submit your own puzzlers for solution, discussion and comment. Also articles telling of any novel ways of meeting emergencies, overcoming difficulties, simplifying the daily routine and improving plant economy.

All accepted articles will be paid for at space rates.

Watch the July issue for "THE PRACTICAL ENGINEER," which will be a department where practical engineers will give and get help in practical daily operation and maintenance of equipment for both generation and utilization of power. It will be a reader's forum for presenting ideas and accomplishment and getting ideas in return. You will get benefit from it as you contribute to it and use it.

WITH THE EDITORS

Taxes and Business

BUSINESS MEN, utility executives, most economists and even officials of the Treasury Department are of the opinion that there is imperative need that tax laws be revised as the present laws arrest the flow of funds into new capital enterprises. Such revision is a major matter now before Congress, and senators and representatives should hear from their constituents on the action desired by them.

Specific changes deemed necessary are, perhaps, best summarized in a report of Brookings Institution, which is practically in agreement with the views of Under-Secretary of the Treasury Hanes. These recommendations are as follows:

Capital stock and excess profits, taxes on corporations and undistributed profits to be abolished.

Old age security taxes to be financed on a pay-as-you-go basis, with only modest contingent reserve, funds of such reserve to be invested in outstanding government bonds and administration of the reserve to be segregated from operations of the Treasury. Tax rate for the present to be not over 1 per cent, to be later increased only as benefit payments necessitate.

For corporations, net incomes up to $3000 to be exempted from income tax. Operating losses to be deductible from income for a period of two years. Capital gains and losses best disregarded, or losses to be deductible in full from gains. Variation of depreciation charges to be allowed in proportion to volume of business.

Corporation dividends to be exempted from personal normal income tax. Personal capital gains or losses eliminated, or full deduction of losses allowed. Surtax rates in upper brackets reduced. Federal personal income tax collected from state employees and state income tax from federal employees.

Since these changes are considered, by most authorities as vital to business recovery, it is important that Congress be made aware of the feeling of the "folks back home" as to their passage. The only way this can be done is to write or wire your senators and representatives. Business needs every possible help to recovery in order to reduce unemployment and make possible better wages and salaries.

Boiler Furnace Operation

NO FEATURE of power plant operation offers so many difficulties as that of furnace operation. The efficiencies secured are apt to vary greatly throughout the day with changes in load, and are markedly affected by changes in the quality of fuels, the condition of the fuel bed, furnace walls and boiler tubes. Furnace design, which includes the proportioning of the combustion space, choice of wall surfaces and selection of fuel burning equipment for a particular grade of fuel, leaves little flexibility in the operating procedure in order to secure highest combustion efficiency at changing loads. The efficiency curve of a single boiler is far from flat over a wide range of load as compared with curves of other units in a power plant.

Through years of scientific investigation it has been determined that boiler efficiency is extremely sensitive to the ability of the boiler to absorb radiant energy from the furnace, probably more so than to other factors involved which are under the immediate control of the operator. That is to say, by varying furnace conditions radiant energy can be greatly increased or decreased by raising or lowering the temperature. This statement seems axiomatic but it is significant that at furnace temperatures around 1900 deg. a rise of 360 deg. F. will more than double the radiant energy released by the furnace.

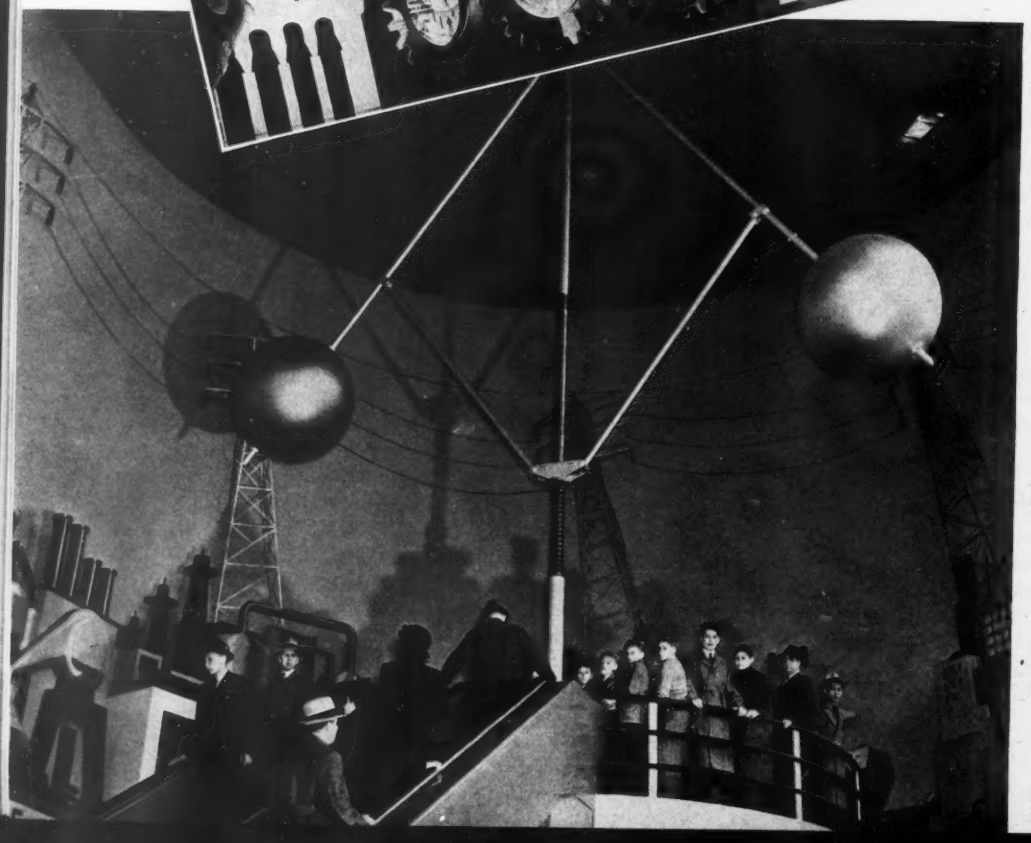
Some of these furnace questions will come up for discussion at the meeting of the Smoke Prevention Association to be held in Milwaukee on June 13 to 16, as there are a number of conflicting ideas on the subject. Stoker and bituminous coal industries favor higher heat release values so that their products may not be penalized by the requirement of expensive and sometimes impossible changes. The boiler and furnace industry needs to know the requirements so that their products may be designed to meet the requirements. Smoke inspectors seem to favor lower heat releases so that they may be reasonably certain of proper operation after installation.

Many years ago engineers adopted the unit of 10 sq. ft. of heating surface in a water tube boiler as a horsepower for rating purposes. It was not long, however, until it was found that some boiler and furnace designs could be operated at two, three and even four times this rating. The answer to this was that older designs depended principally upon the absorption of convection heat while the newer designs are so proportioned as to make more use of radiant heat.

While these facts have been known to scientists and designing engineers, the literature on the subject has usually been so involved with complicated mathematics that the significance of radiant heat to the man in charge of boiler operation has largely been lost. Fortunately, there are writers who are capable of interpreting scientific facts for the men who can use them in their every day work and in this issue is presented an article under the title "Clear and Warmer Furnace Atmosphere" which should help to clarify a number of generally misunderstood conditions and points to means for improving economy in furnace operation.

POWER IN THE

By means of this activated mural the Ford Motor Co. shows the flow of solar energy down through industry to do the work of man. It is believed to be the first activated mural ever built.



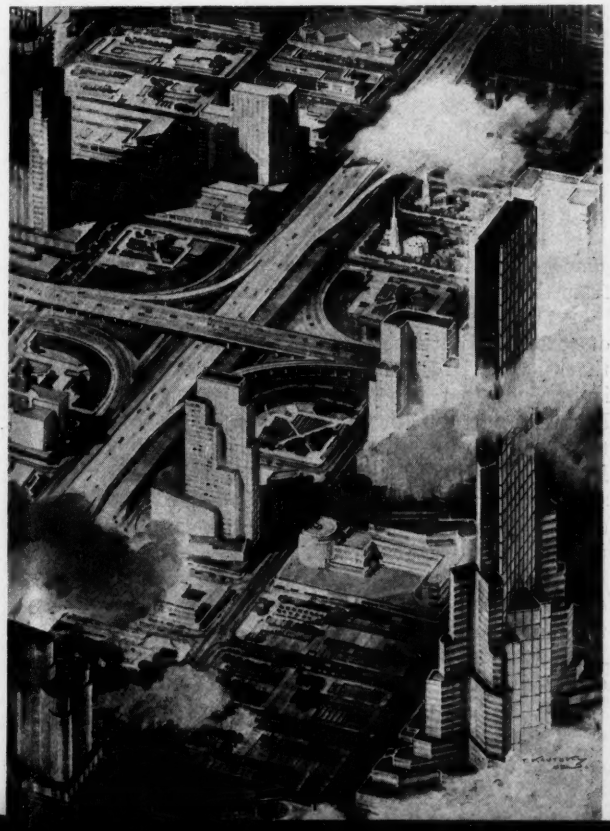
At the left is shown a view in Westinghouse's Hall of Power on one of the opening days of the Fair. As the crowds ascend the electric stairway they reach a high platform above which silently whirls a huge centrifugal governor with aluminum balls six feet in diameter. Symbolic of control, it is a fitting display for the Hall of Power.

At the General Motors exhibit, visitors tour a miniature America of Tomorrow in moving "sound" chairs. A detail of this colorful exhibit, which was designed by Norman Bel Geddes with Albert Kahn as architect, is shown at the right. The 600 chairs each equipped with a sound device, serving as a private guide on the tour, are mounted on a continuous moving "carry-go-round" extending through the building.

WORLD OF TOMORROW

Whatever the World of Tomorrow may have in store for us, it is inevitable that it will be interwoven with power to even a greater extent than the world of the present. It is from the standpoint of the importance of power in the World of Tomorrow that this discussion of the New York World's Fair is presented.

IN THIS YEAR 1939 of the Christian era we can do many things. We can travel swiftly and comfortably over land and sea, we can fly across the oceans, we can communicate instantly and easily with any part of the world, we can see far beyond the limits of our normal vision, we can transform the organic and inorganic materials of the world into marvelous products for our comfort and use, we can build great structures with little human labor, we can generate and transmit power in almost unlimited quantities to remote places, we can record music and speech and store it or transmit it instantly to all parts of the earth, we can record events by pictures and transmit these pictures halfway around the world within the hour. We have conquered many diseases and brought others under control, we have mastered the laws of organic growth and reproduction in plants and animals, we have learned how to store perishable foods, we control the temperature and moisture content of the air in our homes and places of work. We have learned how to produce artificial light cheaply and use it not only to light our homes and places of work but for decorative and artistic effects. We can record the accumulated intelligence of countless generations and can disseminate information throughout the entire world with dispatch, we can reproduce the works of great artists so that even the lowliest among us may see and hear them. We can do all these things and many more.



Now, if we can do these things today there is no reason for assuming that we cannot do them tomorrow, that is, no scientific reason. With the exercise of reasonable intelligence, such as is available in the best minds today, the material resources of the world can be utilized to make these things available to every person in the world. Most of us will no doubt agree that they should be available to everybody even today.

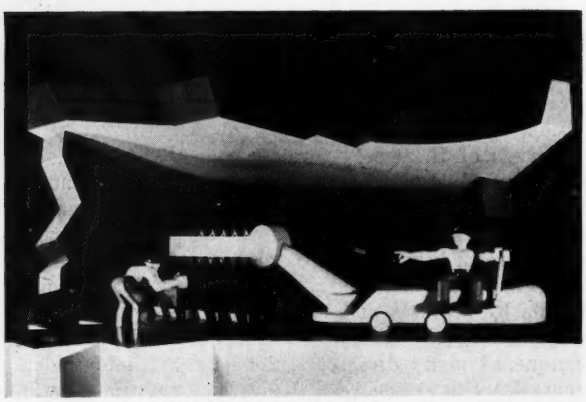
Yet, in this year 1939 of the Christian era we find that only few of the earth's two billion population have them. Furthermore, in this year, we find the world in a state of turmoil and unrest. All over the earth people are uncertain, confused, beset with vague fear of impending disaster. The stability that seems to have been a part of our less technical civilization of yesterday seems to have departed along with the horse and buggy. No longer does anybody seem justified in assuming the continuance of any class of circumstances for any distance into the future. Our most established concepts and institutions seem no more secure than the gold standard which once symbolized solidarity. Everything seems critical. Our newspapers, magazines, writers and speakers are analyzing with almost morbid thoroughness every weak timber of our social and economic structure; radio forums debate "our plight" with fervid seriousness, radio programs emphasize crime and attack by mysterious forces; every newspaper headline screams doom and disaster; in short, the world is jittery.

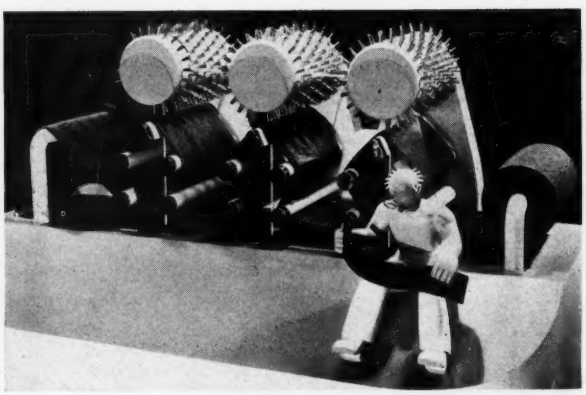
It is into this strange world of conflicting circumstances that the New York World's Fair is launched this month, and for which it presents its theme "The World of Tomorrow".

In view of these conflicting circumstances one may well ask, what can the New York World's Fair really show us about the world of tomorrow? Granted that we can do all the things enumerated above, what assurance have we, in the face of the uncertainty that prevails, that our technical civilization will survive? For, if we can cure disease and prolong life and can build all the things we need for our well-being and comfort, it is also true that we can make bombing planes and machine guns, submarines and poison gas. And, as was pointed out, though we have vast re-

Flip-flop machine at the Westinghouse exhibit provides a study in human interest. Metal disks leap from a heated surface to a cold one and back again, illustrating a thermostatic principle used in many fields of control.

Ford's models of industrial operations are both amusing and symbolic. Below are shown two typical examples, one, of an undercutter used in coal mining and the other, the process of finishing mohair material for Ford motor cars. These exhibits are two of 87 units in the "Ford Cycle of Production."





sources and can utilize them for the benefit of all, the fact remains that only few have these benefits, while countless millions continue to exist on the merest of subsistance levels.

The answer to these questions, we believe, is to be found in light of man's long upward struggle towards his present development. However grim the condition of the world may appear at the present moment, history discloses that this is not altogether a unique or novel condition. Today we are more conscious of our troubles because transportation and communication have brought us all closer together and because the development of external power has vastly extended the capabilities of man. We have more reason to be afraid of things because the time and distance which once separated us from many things now has been practically annihilated. An incident on the other side of the world at 11 A.M. becomes a startling screaming headline in the noon papers.

Fear is an old emotion having its roots deep in our nervous system. It is a protective emotion for it has enabled all animals to survive and civilization could not have developed without it. But the fear which grips us today differs from the fear which in animals warns them of immediate danger. Man is afraid not only of specific dangers but of dangers which exist in the abstract. Hunger, for example, troubles an animal only when his stomach begins to contract but man is troubled by thoughts of hunger, tomorrow, next year, or in old age.

The point we are trying to emphasize in all this is that the terrific demands made upon our minds by the impact of modern technology has caused us, temporarily, at least, to lose our faith in the upward movement of the slow drift of the material circumstances of mankind. Wars may come and wars may go, liberty may wax and wane, population may be enslaved or liberated, and while these are all matters of primary importance to human life and happiness, there is no reason for assuming that they are going to affect the general drift of man's material development. That, from the beginning, has been steadily upward.

As already indicated, we have reached a high state of technological development, and as no less an authority than H. G. Wells has pointed out, nothing is is in sight that will staunch the flow of invention. Regardless of political or economic complications, the trend of mechanical invention and enterprise is likely to be much the same, a little faster or a little slower, cramped or happy, whatever dictators or financial adventurers or patriotisms or fanaticisms may prevail. The ways in which the suburbs of Chicago, Berlin, Moscow or Paris grow follow parallel lines; all the world wears the same rouge and dances to the same tunes.

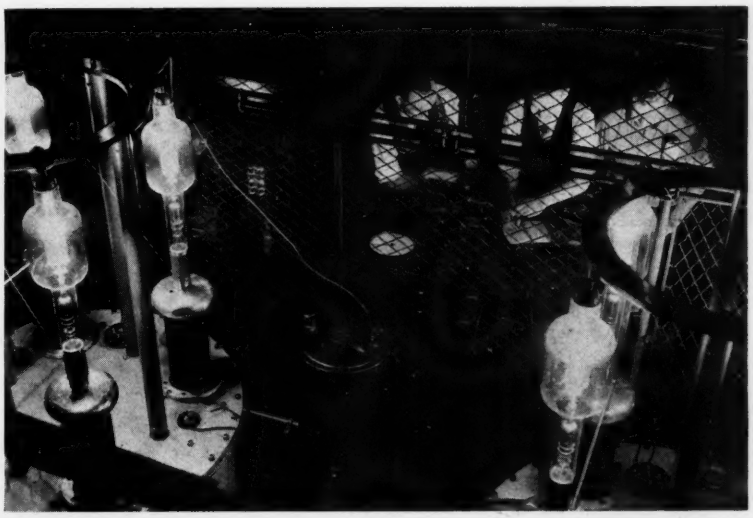
What we do and think, and how we act today is conditioned to a great extent by the tremendous force

of material progress. Whether we like it or no, the motor car, the movies, the radio, chain stores, streamline trains and plastics, mold our thought and direct our behavior. Our social and economic instability can be traced directly to the impact of these inventions on a society that was not conditioned to them.

It is this importance of material things that gives the New York World's Fair the significance it may have in giving us a glimpse of the World of Tomorrow. In many respects the New York World's Fair is no different from Chicago's Century of Progress six years ago. Architecturally it follows the same lines and its exhibits are organized along similar patterns. But where the "Century of Progress" marked an end, the "World of Tomorrow" as its name implies denotes a beginning. Its keynotes are not history and glory but anticipation and hope. It is intended not as a finished picture of a complete whole but rather as a collection of preliminary sketches of the World of Tomorrow. It is an attempt to assemble before us in one great spectacle what can be done by human beings today and what, certainly, if our intelligence is able to direct, we shall be able to do in the relatively near future. In short, the New York World's Fair is an exposition which can, if properly done, give us a glimpse into the sort of world which might follow as a consquence of what we know today.

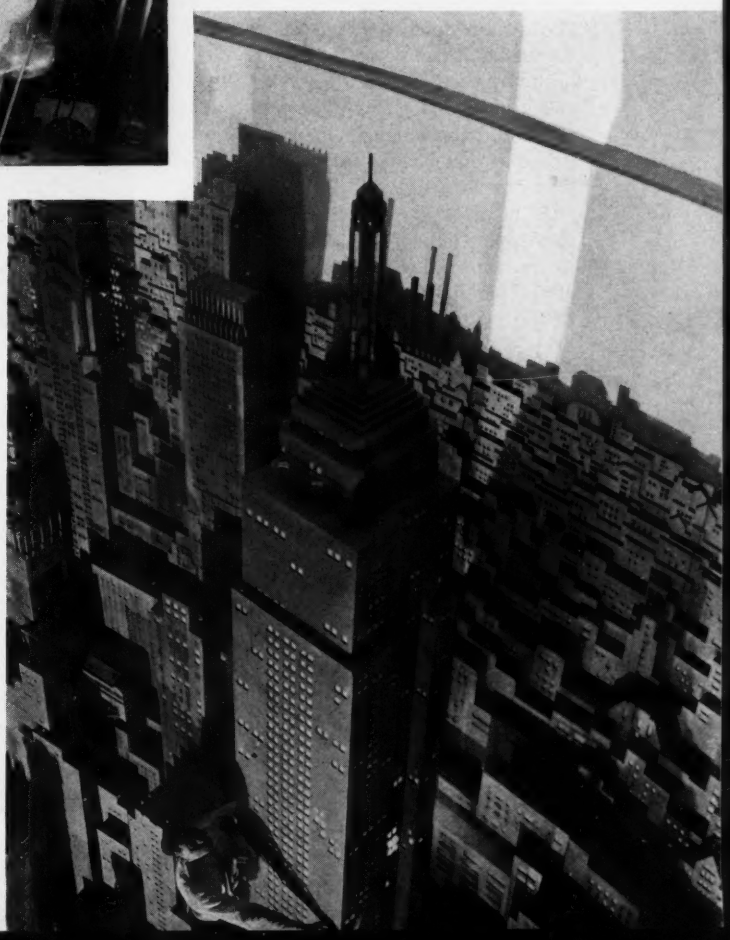
Since its inception some five years ago much has been written about the New York World's Fair. And this year it will be featured and exploited in every newspaper, in every magazine, over nation wide radio hook-ups, in the movies and on the stage in every possible sort of manner. Regardless of what one may feel about world's fairs in general and of one's preconceived opinions of this one in particular, the fact remains that the New York World's Fair is intended as the greatest public show modern industry has ever attempted. From this standpoint alone, if for no other reason, it merits the attention of everybody, whether one expects to attend it or not. In a world in which the natural frontiers have all but vanished, the New York World's Fair represents the spirit of enterprise which has made this nation the greatest force on earth.

So immense an enterprise cannot fail to be an absorbing event in the life of the American people. It has been launched with all the ballyhoo of modern advertising technique and it probably will have the shortcomings of all world's fairs but if, aside from the interest inherent in its sheer magnitude, the Fair can really focus the attention of the average citizen, it may exercise an influence not merely on our future physical progress but on our social planning in the broadest sense. For it is in that field that we can expect to make the greatest future achievements. As has already been pointed out, we can do many things individually; what remains is to coordinate the achievements we have already made into the highly organized and thoroughly integrated environment which we hope will characterize the world of tomorrow.



At the left is shown a view of the high potential rectifiers used in the ten million volt lightning generator in Steinmetz Hall of the General Electric Co. exhibit.

The principal feature of the Consolidated Edison Co. of New York exhibit is the world's largest diorama. The picture below shows a section of this exhibit which is almost a city block long and 37 ft. high. The Empire State Building shown here is 22 ft. high. An 8 ft. section below shows the underground workings of a large city.



Power At The

Bill Gillen, power plant worker, portrays "Bill Jones", average Consolidated Edison System employee, typical of 37,000 electric, gas and steam workers in metropolitan New York. Thirty-one years old, Gillen is an oiler, second grade, at the company's Hudson Ave. Station. His picture will be a feature of the Consolidated Edison exhibit at the Fair.

Below is a view of General Electric Co.'s ten million volt impulse generator in action as the discharge crashes across the 30 ft. gap. Used regularly in test studies at the Pittsfield works of the company the unit has been moved bodily to the New York World's Fair where visitors at Steinmetz Hall can see it in action.

IN PRESENTING THESE ARTICLES on the New York World's Fair, one may ask why they are presented here—in a technical publication concerned with the power industry. Why not leave the New York Fair to the general publications, the newspapers, the radio and the movies? The answer to this question is that we have no intention of describing the Fair in any degree of detail. However, since it is inevitable that "power" is to be interwoven into every element of the world of tomorrow, we feel that a discussion of the Fair in terms of the importance of power is not only desirable but a duty imposed upon us by virtue of the position we occupy in the power industry.

For in the same way that power has played an ever increasing part in our development in the past, so also it is destined to play an ever greater part in the world of tomorrow. At the Fair "power" in the abstract is represented by "The Court of Power" immediately adjacent to the Perisphere and Trylon, the theme center of the exposition. It is significant that the theme center should be flanked on the one side by the Court of Communications and on the other side by the Court of Power. These are the two greatest forces in our civilization.

In a larger sense, however, the exhibition of "power" cannot be confined to a court at the World's Fair. Just as power will be interwoven with every element of our civilization of the future, so power is also interwoven with every element of the New York World's Fair. In electrical energy alone, the Fair will use the equivalent of a city of 500,000 population. Power is on exhibition in every lamp, in every building that has a single electric motor, in every heating or cooling unit, in every electrical, chemical or mechanical process shown, in every means for transport and communication. In the General Motors building, even walking is dispensed with and the visitor is carried through the exhibit area in moving "sound chairs".

In much of what he sees, the visitor at the Fair will see practically no evidence of the power using equipment, but in the windowless buildings he will see remarkable interior lighting effects and at night he will see remarkable exterior lighting effects, exceeding all previous applications. The lighting of the

New York World's Fair

buildings and the displays are in harmony with the spirit and the construction of the buildings and the exhibits in them. This lighting technique is one example of what we meant when we said that the World's Fair gives us a glimpse into the future, for the forms of lighting shown are in advance of public demand by at least a decade. Two years ago we could not have produced the striking blue light in which the Perisphere at the theme center is bathed every night. The use of the short-arc mercury lamps for this purpose opens up a new conception of city and suburban street and parkway lighting.

In addition to lighting, electricity performs countless other services at the Fair. It provides power for air conditioning the buildings and for the operation of pumps for various fountain displays. One fountain display alone requires over 2000 hp. to operate the pumps and in addition 2000 kw. for the lighting effects.

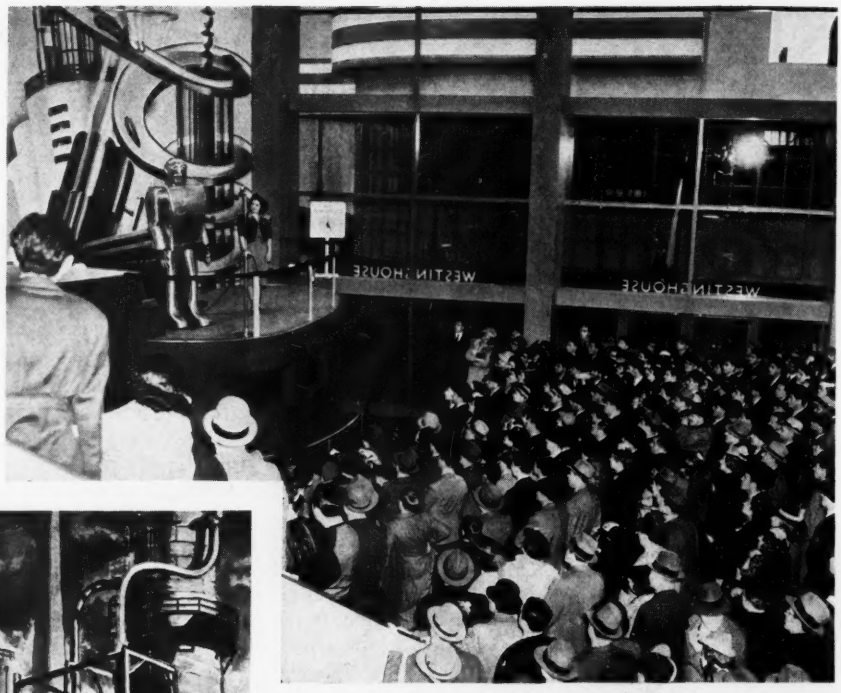
The lighting features at the Fair incorporate many new designs of lamps and principles of illumination. One of these features is the extensive use of ultra violet light from mercury vapor lamps. By projecting this light against the underside of the leaves of trees it produces luminescent effects of startling beauty. Below are shown the trees along Constitution Mall, alive with light from capillary mercury lamps hidden in the ground.

To supply all the electrical energy needed, two substations have been built, one on each side of the main exhibit area. The total ultimate capacity of these two substations will be 90,000 kv-a. The expected load will be about one-third of that for the entire County of Queens, which with a population estimated at a million and a half means that the electrical installation at the Fair is equivalent to that necessary for a city of a half million people. Yet all of this power is consumed in an area of about two square miles.

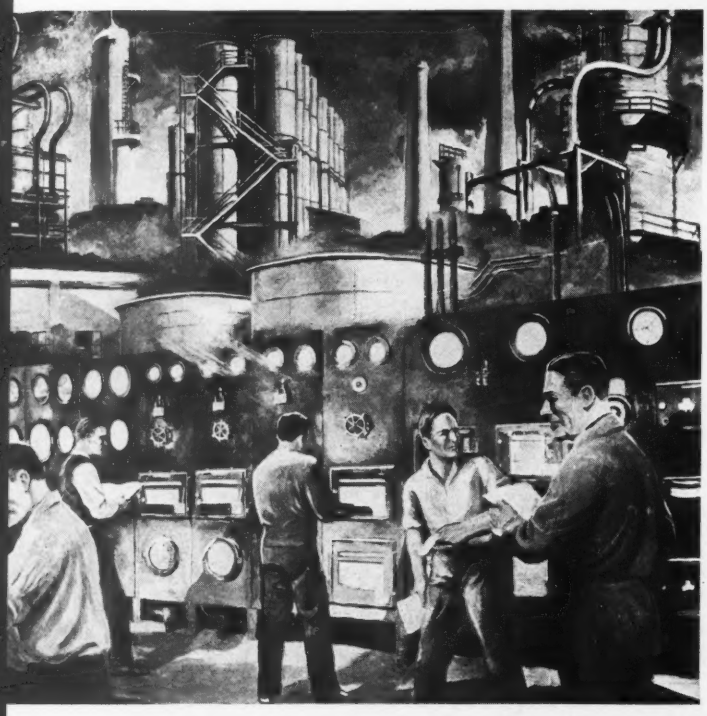
All this power is supplied from the system of the Consolidated Edison Company of New York. The power is brought into the substations at 27,000 v. and transformed to 4000 v. for distribution throughout the Fair grounds.

While these statistics concerning the power supply system at the Fair are interesting from the standpoint of magnitude, they represent after all, only everyday matters for the electrical engineer and give no inkling

"Elektro," the 7 ft. 260 lb. robot, attracts much attention at the Westinghouse exhibit. He is the most versatile mechanical man ever built. He can stride forward or backward, talk, sing, smoke, distinguish colors, count on his fingers and perform other human acts—all at the spoken command of his directors.



The picture below is one of four murals shown at the Petroleum Industry exhibit. This one represents the refining of petroleum. Each mural measures 39 by 48 ft.



regarding the size and complexity of the exposition as a whole. To grasp the essence of the exposition will be the most difficult thing the serious-minded visitor will have to do.

There is a plan, and a theme, and there is a great deal of attempt at coordination, but the Fair as a whole, it seems to us, far from presenting an accurate picture of the world of tomorrow, eloquently reflects the lack of coordination which characterizes the world today. This constitutes no criticism of the Fair nor of its promoters. Under the circumstances they have done the best they could, and, as indicated in the foregoing, the Fair must not be considered as a finished picture but rather as a collection of ideas which may fit into the complete picture of the world of tomorrow. The Fair must be viewed in the light of intelligence. One must select from the multitude of general and miscellaneous things the values which are destined to enter into the structure of the World of Tomorrow.

Consider for a moment one feature of the Westinghouse exhibit—Elektro, the electrical robot. Elektro is a mighty automaton, the youngest of a famous line of mechanical men that have been born in the Westinghouse laboratories. He weighs 260 lb., walks, talks, smokes, selects colors and can count. From a mechanical and electrical standpoint he is quite a marvel and his performance will amuse hundreds of thousands of visitors throughout the summer.

But he looks like a moron, and frankly he is a low grade moron. Watching him, after the novelty of first seeing him has worn away, one concludes that if this is the best thing science with all its years of research and effort can do in the way of making a man, it had better give up the attempt as a poor job. Elektro, however, must not be regarded as an attempt of science to create a man. Science can never hope to do that, and this mechanical man at the Fair must be regarded only as a by-product of sciences' accomplishments in other directions. The photoelectric cells, relays, amplifiers, which enter into his make-up are all elements of modern electrical communication and power circuits that have no connection with the design of a mechanical man. As the engineers of the Westinghouse Co. themselves point out, no engineer would be so ridiculous as to imagine that any robot could ever take the place of man. The robot as such tells us nothing about the world of tomorrow, but his relays, photocells and amplifiers do.

Electricity Direct From Heat

Far less spectacular than the mechanical man but much more significant in its import upon the future is another exhibit at the Westinghouse building. This

is a small mechanism looking like a large tube cake pan heated by a small gas flame. This apparatus converts the heat of the gas flame directly into electricity, furnishing enough power to run a small fan or to light a small lamp. It is a small device with no practical application and even the principle upon which it operates is not new, but, if we can generate electricity in this way on a small scale, the implication is that we may be able to learn to do it on a large scale in the future.

Those of us associated with modern boiler plants can appreciate the possibilities inherent in this conversion of heat directly into electricity. Marvelous as has been the advance in boiler design, the modern boiler is a terribly involved and complicated affair, inordinately costly and difficult to control. Suppose that by a development of some such principle as shown at the Westinghouse building we could convert the heat energy of combustion directly into electric power, on a large scale and at an efficiency no greater than that involved in the power plant of today, think of what that would mean in the way of simplifying power production and distribution systems. True, it would be disastrous for the boiler and turbine manufacturers but these would have to make adjustments.

Ten Million Volts in Action

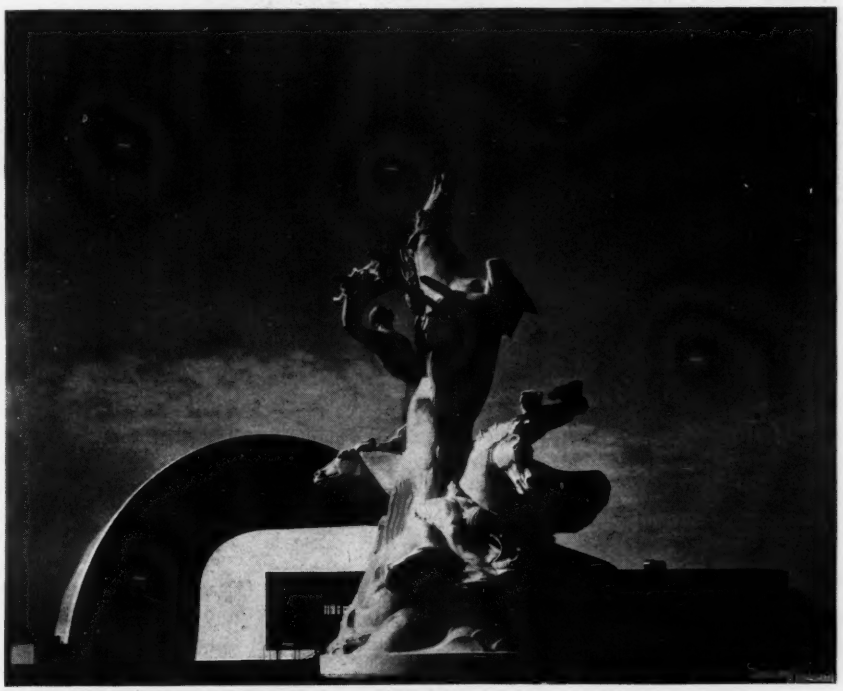
It is in these little things that one must find expression of the theme of the World's Fair, not in the big things designed primarily to catch the eye. Of course, there are big things; spectacular things which have quite an obvious relationship to the World of Tomorrow. One of these, for example, is the 10,000,000 v. lightning generator in Steinmetz Hall at the General Electric Co. exhibit. To power plant engineers this will be no particular novelty; even if they have never seen such a device in action they will know something about it, but it will startle and intrigue many thousands of people who do not ordinarily have opportunities to see such equipment. This generator signifies far more than the ability to startle the crowds with its resounding crash as 10,000,000 v. lightning strokes leap across the thirty foot gap; it signifies great skill in the control of the greatest force available to man—electricity. Time was when lightning was a mysterious force, held in leash by the gods and used by them to wreck their vengeance upon mankind. Today man reconstructs these forces and uses them to improve and extend his skill in the transmission of electrical energy over great areas of the earth's surface. And what he knows of this force today will aid him in bringing about that better world of tomorrow of which we dream.

Electrical and Industrial Exhibits

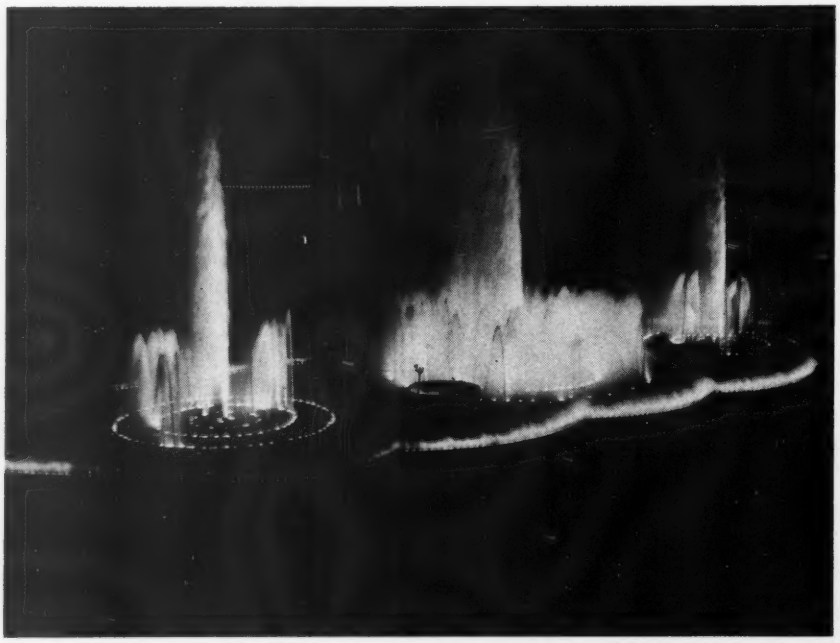
IN THE TWO PRECEDING SECTIONS of this discussion of the New York World's Fair, we have considered only the more general and underlying aspects of the exposition. Now, without in any way attempting to be comprehensive we will consider the exhibits which are of particular or specific interest to those associated with the power industry.

Lighting

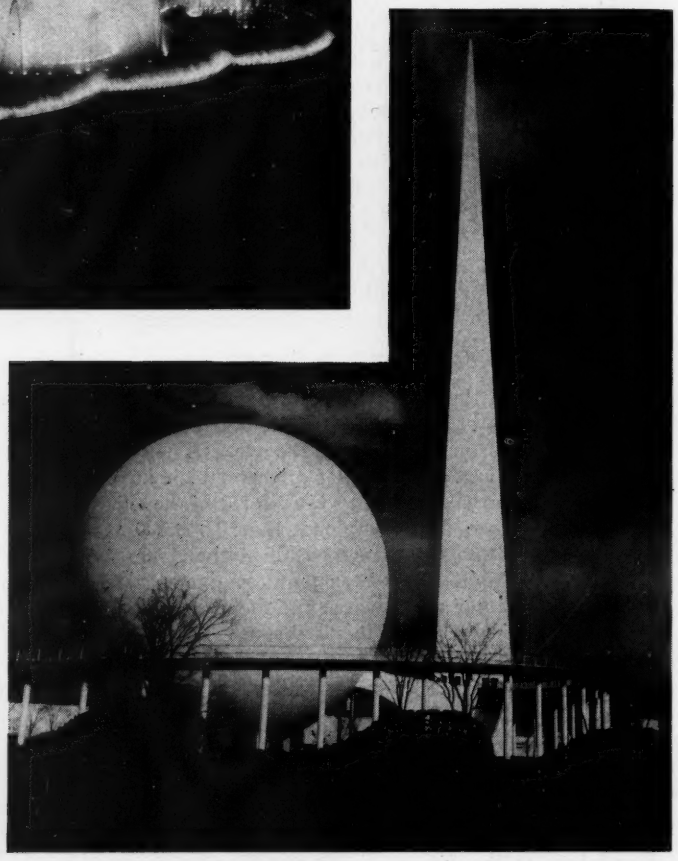
Not of least importance to the power industry is the lighting at the Fair. New lamps and lighting units, years in advance of their normal time, make their large scale commercial debut. These include 400 watt short



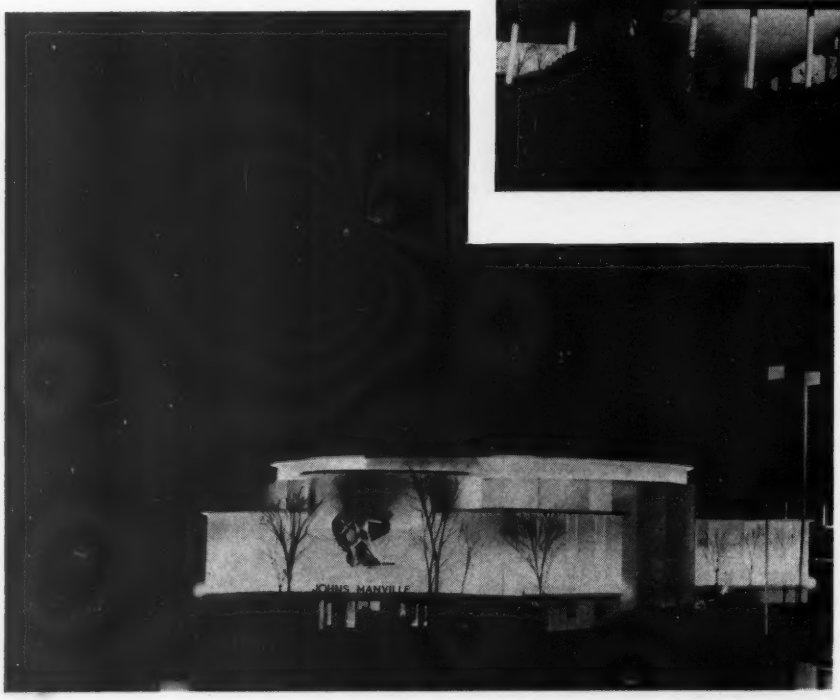
One of the loveliest pieces of sculpture at the Fair is this fountain called "Riders of the Elements." The statue, standing at the intersection of the Court of Ships, the Avenue of Transportation and the Bridge of Wings, symbolizes man hurling himself into the air and over the earth and water. The product of Chester Beach, this work gives dynamic expression to the theme of the Transportation sector of the Exposition.



A fountain symphony blending colored light from 585 submerged twin projectors with synchronized water jets, music, gas flames and fireworks, is the nightly final spectacle at the New York Fair. The 11 pumps for this fountain require some 2700 kw. and some 1500 kw. of power is needed for lighting. It is located in the Lagoon of Nations.



The Trylon and the Perisphere need no introduction. The Theme Center of the World's Fair, they represent geometry's simplest and most fundamental forms. The Trylon is 700 ft. high, the Perisphere 200 ft. in diameter. Inside the globe is a dynamic spectacle combining music, motion pictures, diorama and light in a new technique which dramatizes the theme of the Fair. Entrance to the show is through the Trylon on one of the longest moving stairways in the world.



Motion pictures, dramatic mural presentations and a series of fascinating displays in the Johns-Manville Building tell the story of how four of nature's minerals — asbestos, diatomaceous earth, limestone and asphalt have been transformed through research into hundreds of products useful in both home and industry.

arc, high intensity mercury vapor lamps, the 1000 watt water cooled mercury vapor lamps, soft colored fluorescent lamps and special World's Fair flush-type fixtures with fresnel lenses, having vertical colored risers for interior lighting.

The Lagoon of Nations fountain is lighted by 585 twin-unit mobile color drums; each using a 400 watt mercury lamp and a 1500 watt Mazda. The mobile color effects are aided by twelve 2100 watt search lights—1500 kw. being required for the lighting of the fountain.

The use of mercury vapor night lighting intensifies the detail and color in the brilliant mural which Eugene Savage has painted on the facade of the Communications Building. The composition relates to the story of communication and builds its narrative from Indian smoke signals to radio around the figure of Atlas.

The Theme center Perisphere is bathed in strong blue light from the new 400 watt mercury lamps. Light from 30 units, each with 9 lamps, is directed to the Perisphere from adjacent buildings. Supplementing the blue mercury lights are 40 projectors with 5 kw. incandescent lamps. The total light for the Perisphere requires over 300 kw.

As already mentioned the Theme Center, marked by the Perisphere and Trylon, is flanked on one side by the Court of Communications and on the other side by the Court of Power. Along the latter are grouped the buildings of the General Electric and Westinghouse Cos., the electrical products building, the electrical utilities building, the Consolidated Edison Co. building, the metals building, the U. S. Steel building, Glass Inc., the Petroleum Industries building, the Hall of Industrial Science, Dupont, Carrier, and Elgin Watch.

Around the Court of Communications, are the R.C.A. and A.T.& T. buildings, the Communications building and the Crosley building.

It will be noted, in each of these groups there are duplications. In the communications group there is a communications building as well as buildings of R.C.A. and A.T.& T. All of these exhibits naturally are concerned largely with communication and there is bound to be a certain amount of duplication. The Communications Building in this group is one of seven "focal" exhibits, staged by the Fair itself. The focal exhibits are provided to interpret and explain the commercial exhibits surrounding them.

In all of these exhibits around the Courts of Communication and Power, it is *electrical power* that is emphasized. In addition to the exhibits of the electrical manufacturers and the special exhibit of the Consolidated Edison Co., the electric utility companies as a whole are represented in two exhibits known as Forward March of America and the all electric farm.

The Forward March of America

The Forward March of America exhibit is built in the form of a U around a landscape court. One arm of the U is a long wing with sloping walls housing the Street of Yesterday, the base is a similar structure which contains the Avenue of Tomorrow while the other arm contains a spectacular "Rocket Room."

On entering the exhibit, the visitor finds himself in a theatre lobby of 1882. From the lobby he walks out into a typical street of 50 yr. ago, with cobblestones, horse drawn street car, a maze of telegraph wires overhead and with homes and shops crowded together along narrow sidewalks.

At the end of the street is the office of the electric light company celebrating the tenth anniversary of the industry. From this office, the visitor walks through a curved passage into the well lighted lobby of a modern electric utility. From here he sees stretched out before him a street of modern buildings ablaze with light and with all the trappings of extreme modernism.

In the Rocket Room a spectacle of light, color and sound is produced electrically, giving visitors the impression of being projected into space on a rocket.

At the other end of the exposition, along the banks of Flushing Creek, is the other half of the electric utility exhibit, the All Electric Farm. Here visitors find a practical, working farm, complete with buildings, stock and fields. Although some of the electrical equipment used on this farm will be shown to the public for the first time, it all represents practical applications within the means of the average farmer. Many of the farm operations are carried out daily so that one may see at first hand how electricity makes life on the farm more comfortable and how

it puts money in the pocket of the farmer who avails himself of up-to-date electrical equipment.

Not a part of the All Electric Farm exhibit but of a similar nature is the exhibit of The Borden Co. in the "food" sector. Here is shown the most advanced, scientific milking system, devised in America, the Rotolactor operation of the Walker-Gordon Farms at Plainsboro, New Jersey. The Rotolactor is an electrically operated platform 60 ft. in diameter with a capacity of 50 cows at a time. On this contrivance more than 1500 cows are milked three times a day. Each time a cow walks upon the platform and enters her stanchion she is bathed with water at body temperature, dried with an individual sterilized cloth. Thereafter, while an overhead transparent jar which is to receive her milk is being sterilized, a sample of the cow's milk is taken by an inspector. When the sample is approved, the milking tubes are attached and the milk is pumped into the jars.

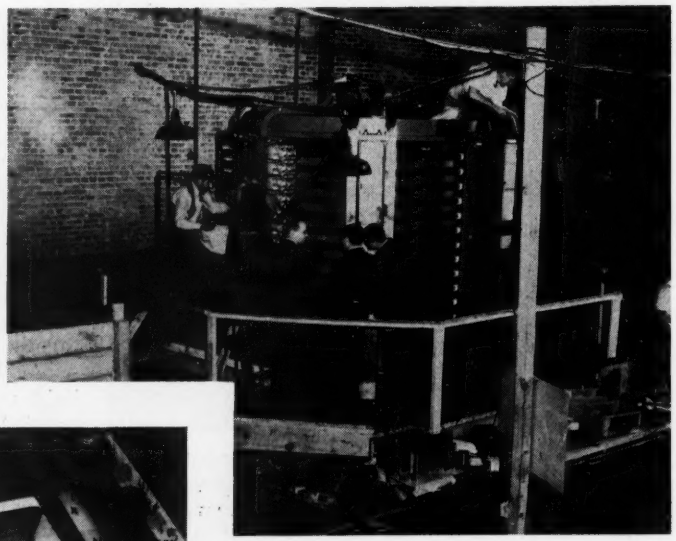
Consolidated Edison Co. Exhibit

The Consolidated Edison Co., which supplies electric, gas and steam service to Greater New York, is the only central station system having its own building. At this exhibit is presented the world's largest diorama and a sequence of animated, three-dimensional displays illustrating utility service in a metropolitan city.

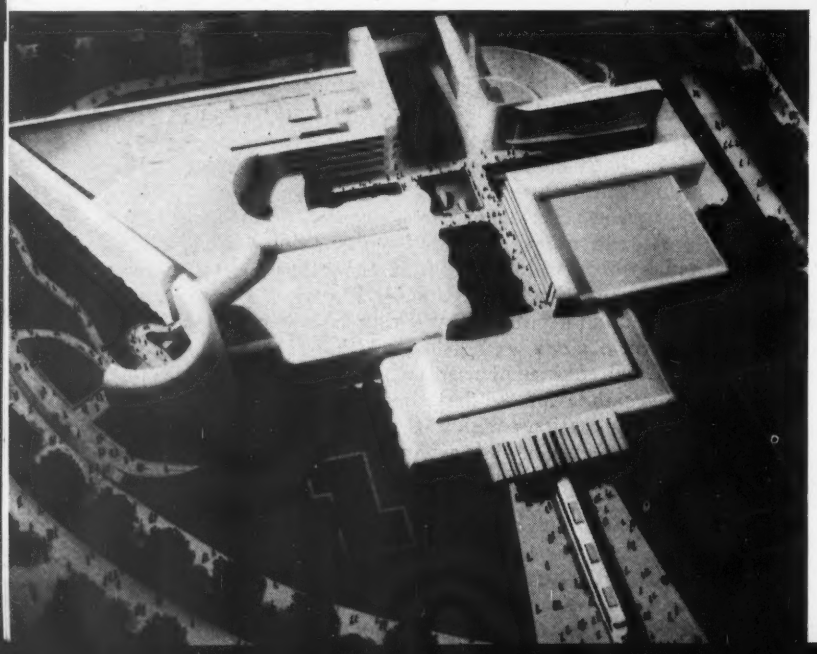
The diorama, composed of more than 4000 buildings studded with 130,000 windows, is the most elaborate work of its kind ever constructed, combining effects drawn from the musical, dramatic and architectural arts. In height it is equal to a three story building and it is nearly a city block long. From skyline to subway it presents an impression of New York but it is not a diorama of New York. Many of New York's famous buildings are represented but they are not disposed according to their actual geographical location. Impressive as this spectacle is, the fact that it is not an accurate representation of New York is disappointing. In view of the immense amount of work put on it, and the expense involved, it would seem that it would have been quite as easy to make it realistic. But there is no way of accounting for the workings of the creative artist's mind. The exhibit was designed by Walter Dorwin Teague.

In this diorama, certain of the Consolidated Edison System properties are shown in animated detail. These include the steam electric generating stations, gas plants, and a steam station.

Besides the diorama, the Consolidated Edison Exhibition structure contains a sequence of animated,



The strange device shown at the right is the 20 ton multi-voice speaker mechanism which serves as a corps of "private guides" to visitors touring the General Motors "Highways and Horizons" exhibit. Said to be the most intricate sound system ever developed, this unit delivers 150 different descriptive talks at the same time. It enables spectators traveling in moving "sound" chairs to hear a perfectly synchronized description of the exact scene they are viewing.



The largest single building at the Fair is the General Motors Highways and Horizons exhibit. Designed by Norman Bel Geddes, the exhibit actually is 4 buildings located on the 4 corners of a spectacular and imaginary full scale street intersection of the future. The buildings join into the overall exhibit structure by elevated pedestrian sidewalks which extend for a full city block in two directions. The street below is designed for motor traffic and contains 60 motorcars, buses and taxicabs.

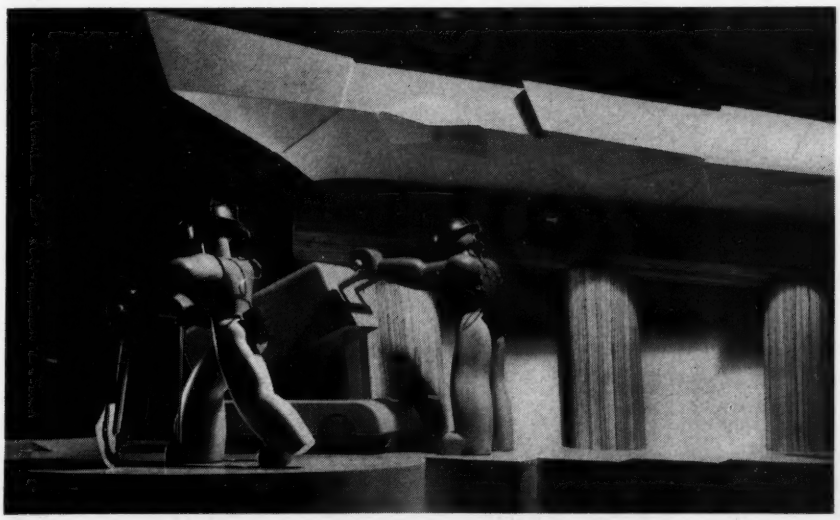
three-dimensional exhibits intended to illustrate the part played by the utility system in metropolitan area life. Certain of these exhibits dramatize the work of "Bill Jones" who typifies the Consolidated Edison System's 40,000 employees.

General Electric Co.

As already mentioned, the General Electric Co.'s display presents the first public demonstration of man-made lightning. The ten million volt lightning generator used at the Pittsfield testing laboratory has been reproduced in Steinmetz Hall where 600 persons a day may view the spectacular demonstration.

The G. E. Building features three general sections, one devoted to product display, one having "The House of Magic" auditorium, and Steinmetz Hall in which the lightning generator is located. In the product display area, a varied group of products is displayed —television, X-rays, plastic presses, a magic kitchen table which talks, sings and does its own version of a dance. Here also is displayed the enormous mural by Rockwell Kent, a single painting on a canvas 50 by 15 ft. This mural symbolizes the story of electric power. Although spectacular from the standpoint of size, this painting is open to the criticism that can be applied to so many works of modern artists who endeavor to symbolize the advance of science. They are often quite childish in their presentation and too frequently comprise a conglomeration of badly drawn machinery and grotesque human figures. This mural symbolizing the achievement of contemporary science in contrast with the science of the dark ages by Rockwell Kent is no exception, and however spectacular it may be from the standpoint of size and color, in our opinion at least it adds nothing to the artistic accomplishment of the age. It is hopelessly inadequate in portraying the brilliant advance of science through the ages.

This criticism of Rockwell Kent's mural applies more or less generally to the murals throughout the Fair. It is true, there is a great variety in the means of expression and in the use of color and different materials, but much of it implies the same confusion of mind and of purpose among the artists as characterizes the social and economic world today. The artists were given more or less free rein in their selection of subjects and use of materials, and while some of the results are pleasing, in general they fall far below the standard of excellence embodied in scientific and industrial achievements of our civilization.

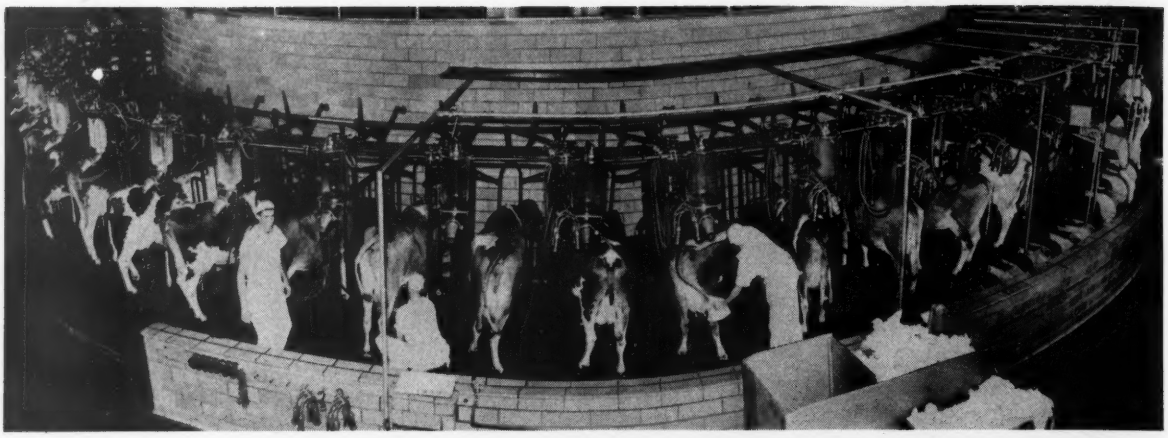


Here, at the left, is another model in the "Ford Cycle of Production." This model shows how copper ore is dumped into a chute to convey it from one level to another.

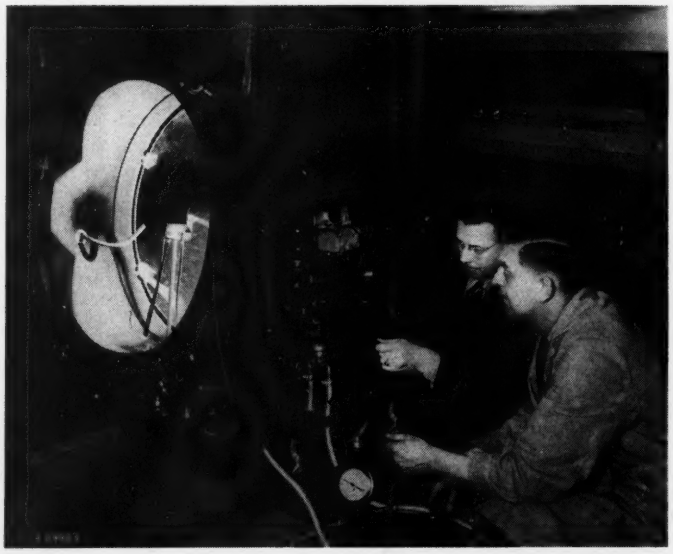
Below: Rockwell Kent at work on the 15 by 50 ft. mural for the General Electric Building. In the foreground are the discarded tools of mankind. Excitedly, people point out the electrified world of the future in which they shall at last be free of drudgery.

The new "House of Magic" at the G.E. exhibit is more interesting than ever. Colors in the theatre and in the clothes of the audience change with the changing light of incandescent, mercury, sodium, neon and ultraviolet lamps. Music and sound effects parade around the theatre through a system which imperceptibly fades the sound from one concealed speaker to another.

Among other things presented in the House of Magic, a miniature electric train is controlled by voice. In another "stunt" the demonstrator floats an aluminum bowl in the air, then walks off the stage, leaving



The "Rotolactor," the merry-go-round for cows, on which cows are milked by electric milking machines at the New York World's Fair.



At the right, Engineer E. L. Beach (left) explains to test inspector E. A. Domsiers the control system of the new type 30 inch 1000 watt water cooled mercury lamp searchlight being made by the Lighting Division of the Westinghouse Electric and Mfg. Co. In the foreground the water lines can be seen running into the control box. The searchlight is shown actually burning. Sixteen of these big 30 in. units illuminate the parade ground at the Fair.

his shadow behind, finally returning to have a new shadow shake hands with the one he had just forgotten.

WESTINGHOUSE ELECTRIC & MFG. CO.

The Westinghouse Building is magnet in shape and two stories high. One end of the magnet is known as the Hall of Power and the other the Hall of Electrical Living. In the open court between them is the theme center, known as the singing tower, a 120 ft. inverted cone of horizontal rings that is the stage for dramatic displays of water, light, music and fireworks.

In the Hall of Power are shown operating exhibits of the generation and transmission of electricity and its application in seven major industries. Spectators have an opportunity to participate in the demonstration. For example, those who have been obsessed with a secret desire to be a motorman on a street car can step onto a Westinghouse electric car, sit in the motorman's seat and operate the controls which move a model car on the exhibit wall. In the "Playground of Science" one can weigh himself by electricity, see the shape of his voice, watch the Phantocycle, a riderless bicycle pedaling endlessly away while being steered and kept upright by a beam of light acting on a photocell.

Dominating the Hall of Electrical Living is Elektro, the 6 ft. 10 in. robot referred to in a foregoing paragraph. By means of cams, gears, motors and photoelectric cells he walks, counts with his fingers, recognizes and names smells and colors, smokes cigarettes and talks on a variety of subjects. His favorite colors are red and green, in fact they are the only colors he sees and when they are flashed before his eyes, he speaks out "red" or "green" as the case may be. He is at his prodigious best, however, when it comes to smoking. He not only puffs and inhales but he blows the smoke in great bellows from both nostrils.

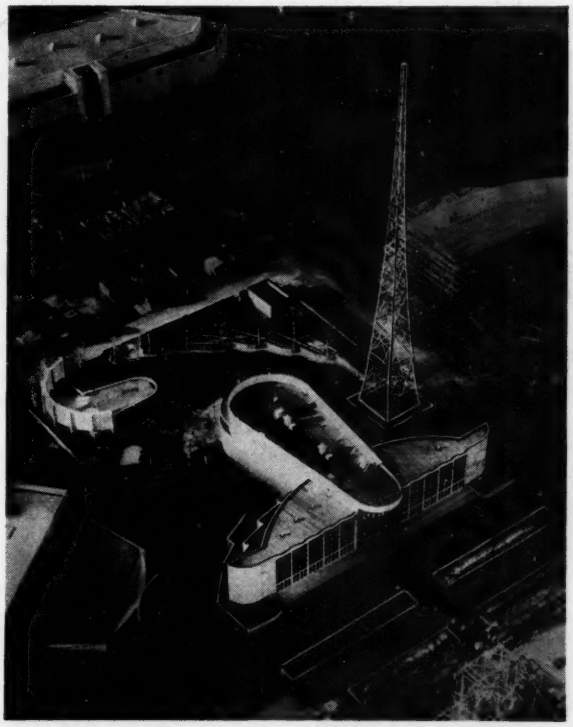
Dominating the Hall of Power is a huge governor more than 40 ft. high set on a platform in the center. As it rotates, two flashing six foot steel spheres swing around a circle 30 ft. in diameter. On the upper floor of this building are more than a score of exhibits, dramatically arranged to explain some little known facts of the physical, biological and industrial world. One of these is the famous Microvivarium originated

by Dr. George Roemmart. In this fantastic microscope visitors see enlarged 2000 times and projected on 12 circular screens, the frenzied birth, life and death of scores of tiny micro-animals whose world is a drop of water. As the "curtain scene" of this microscope drama, Dr. Roemmart brings into play the Westinghouse Sterilamp under the deadly beam of which the performers in this strange world are killed almost instantaneously.

The switchgear controlling the 2500 or more kilowatts required for the Westinghouse exhibits serves both the purpose of utility and exhibition. The switchboard is built in an unusual, slightly curved shape and is finished in blue-green lacquer trimmed in chromium. The copper bus bars are silver plated and rest on black finished Micarta supports.

Communication

It is in the Communication Exhibits that the visitors at the New York World's Fair will get their real glimpse of the "World of Tomorrow" for there for the first time in America practical television will



R.C.A. building and antenna tower. An aerial view of this building designed in the shape of a huge radio tube lying on its side, attached to a base, symbolic of the radio industry.

be shown. The import of this can scarcely be overemphasized. Television is the one absolutely new thing at the Fair, and though its use will be limited for years to come, it is inevitable that this highest and most difficult of developments in the communication art will become a powerful force in the world of tomorrow.

The communication group of exhibits consists of a Communications Focal exhibit housed in a separate building, and the buildings of R.C.A., A.T.&T. Co. and Crosley Radio. All these buildings are grouped around The Court of Communications.

The Focal exhibit in this group is staged in a great hall sunk in darkness but for a fluorescent mural covering the entire left wall. Glowing softly, it portrays in montage fashion various basic inventions such as the Indian's smoke-signal and Franklin's kite experiment which have made possible present day communication facilities. The entire action takes place overhead. Between presentations visitors gaze through eye level port-hole exhibits into imaginative conceptions of the future telephones, radios, etc.

Dominating the entire hall which extends 180 ft. in length, a 20 ft. head of Man, modeled of plastic and stainless steel, is suspended in mid-air. At the far end of the hall a 30 ft. rubber globe of the world similarly hung rotates in space. The exhibits portray man projecting his thoughts through instruments of communication. As Man speaks, the symbols for the seven major instruments of communication materialize on a plastic disc in front of Man, and their image is projected in shadow form on the revolving globe. Simultaneously, montage panels corresponding to each symbol light up on the right wall.

The Bell System, that is, the A.T.&T. building. occupies a triangular plot of more than three acres. The building and its exhibits are many times larger than telephone displays at previous expositions. One of the chief exhibits is "Pedro the Voder." This is an electrical device which creates speech—the first machine in the world to do this. It contains no phonograph or sound film. Looking like an old fashioned organ with keyboard and pedal, Pedro speaks at the direction of a young woman operator.

At the long distance demonstration calls are made by visitors chosen at random. Another exhibit features the "voice mirror." This device records the visitor's voice as he speaks over the telephone and then returns it to him through the receiver. One section is devoted to an exhibit of old and new telephone equipment, showing the evolution of the telephone since its invention by Alexander Bell.

The R.C.A. Building is built in the shape of a huge radio tube lying on its side, attached to a base. The entire front of the building is enclosed by plate glass windows and doors. At the side of the building is the antenna tower used for the reception and transmission of television, facsimile and sound broadcasting.

Television equipment is demonstrated by both General Electric and Westinghouse as well as R.C.A. but R.C.A. has inaugurated regular television service from its Empire State Building transmitter with the opening of the exposition.

Although we have implied the importance of television in the world of tomorrow, nobody at the present time, even those who have developed it, can say how it will be used. It has been said that television is the child of art and science—and so it is, in a way. But, however, blissfully art and science may be wedded, the child is no ordinary child and there is no telling what problems it will bring upon us. Gov-

ernment and money are deeply disturbed about its future.

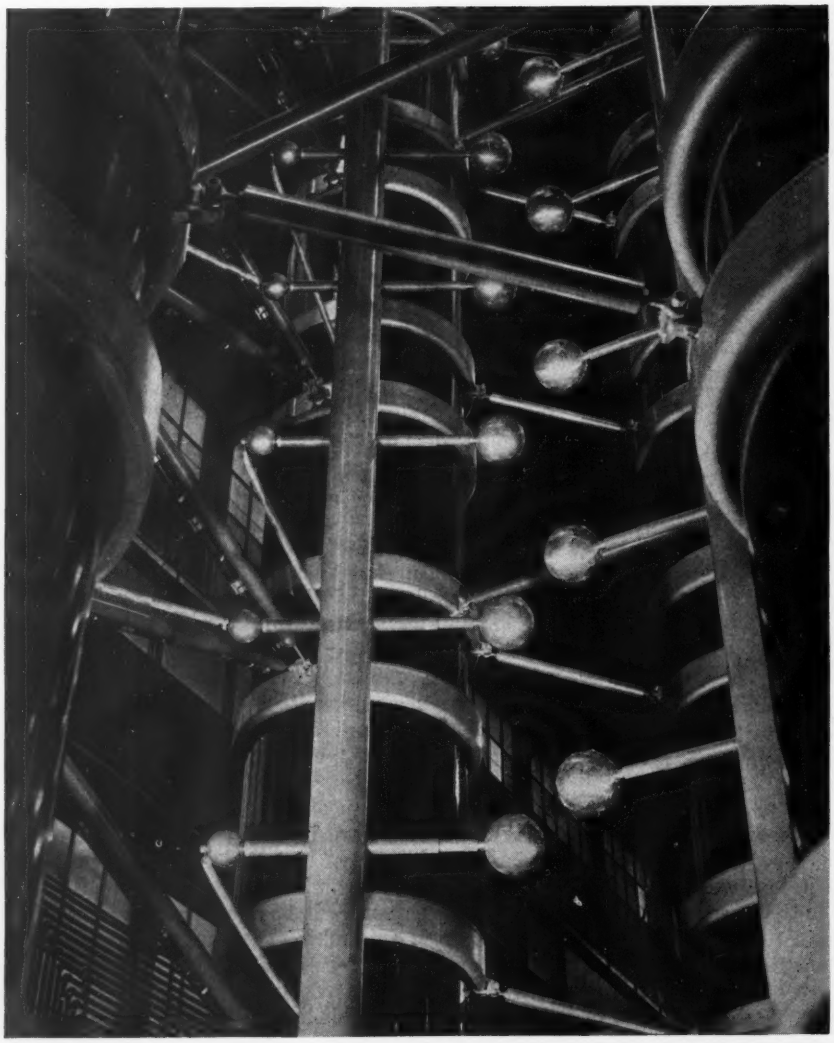
Most of us have been interested in watching the development of the technical aspects of television. This has been incredibly complex and difficult but now after the expenditure of millions upon millions of dollars and the marshalling of all the resources of science and human ingenuity, we have arrived at a stage where to a limited degree it can be given to the world. The technical difficulties of television, however, are probably no greater than the difficulties which confront us in its social application and many competent minds are worrying about it. The perfection of television provides the means of access to public credulity and the power which that access gives, lie open to some man's grasp—and not enough people know that. Moreover, television may disrupt a number of enormously powerful agencies. The movie industry has its fears and the present broadcasting industry is none too safe from its effects, despite the fact that this is the industry to which television owes its birth.

The television shown at the World's Fair is of a high order of technical excellence. As those who were at the Century of Progress in Chicago may recall, television demonstrations were held there, but this was of a low order of perfection, in fact it made use of a system which was doomed to failure from the beginning. High speed rotating mechanical equipment is incompatible with the extreme speed and accuracy requirements of television, and in the years since 1933 most of the mechanical scanning systems have vanished and in their place we have the electronic systems of today.

Industrial Exhibits

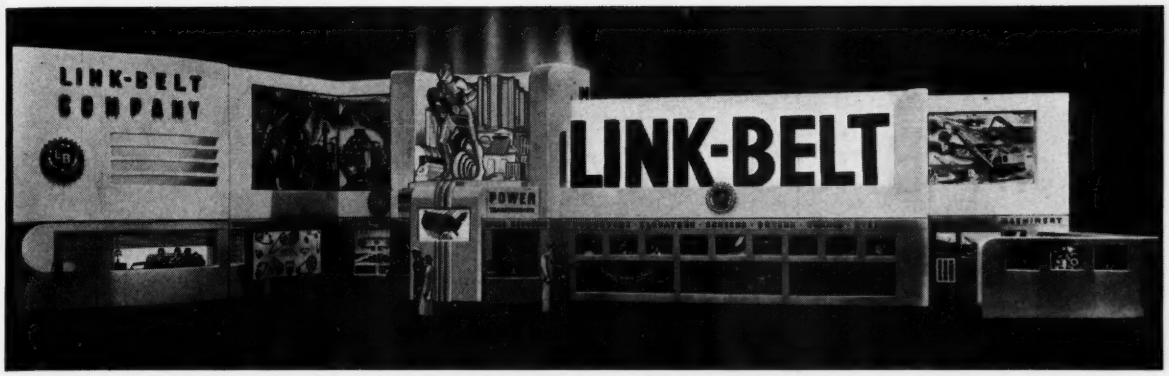
One of the most unusual buildings at the Fair is that of the United States Steel Co. and which houses its exhibits. This building has been referred to as an "inside-out" structure, since it is supported by external structural members. It is built in the form of a great dome—a smooth hemisphere of stainless steel—60 ft. high and covering an area of 28,000 sq. ft. The entire dome is supported by ten steel curved trusses supported in concrete at the base and meeting at a point 72 ft. above the ground. This steel framework is blue in color and conceals lighting fixtures to illuminate the burnished dome at night.

Inside, the building contains two floors of exhibits showing how steel in a thousand forms is basic to our civilization and how through research it is helping to shape the world of tomorrow. A feature of the story of steel is a diorama portraying in great detail an actual mountain range —the Mesabi Range of the Lake Superior region, America's principal source of iron ore.



An Unusual View of General Electric's Ten Million Volt Lightning Generator

At the New York Fair, the general public will for the first time have the opportunity to see the production of man made lightning flashes. From the preliminary work done in this field by Steinmetz years ago, impulse generator voltages have been pushed gradually higher. From 2,400,000 v. in 1927 they have gone to 3,600,000 v. in 1928, 5,000,000 in 1929 and finally to 10,000,000 v., which is the highest attained at present



Link Belt Co.'s exhibit in the Metals Building portrays by working models, photo murals and colorful dioramas how industry can ease labor's burdens.

A considerable portion of the first floor is used to portray steel making operations. In addition to the ore-mining diorama, a miniature blast furnace, open hearth furnace and rolling mill illustrate steel making from iron ore to finished product. On the second floor a large scale cyclorama portrays the possible evolution of the city, the farm, the factory, the highway and the home as built with steel.

In the Metals Building, the exhibit of the Engelhard Industries; Baker & Co., Inc., Hanovin Chemical & Mfg. Co., Irvington Smelting & Refining Works, American Platinum Works and Charles Engelhard, Inc., present a unique opportunity for the visitor to observe, probably for the first time, how vitally important are platinum and other precious metals to our civilization and to see apparatus and scientific instruments that otherwise would be but names to him.

The application of the invisible rays of ultra-violet light are shown at the Hanovia Chemical & Mfg. Co. exhibit. While all of us know about the beneficial effects of ultra-violet in natural sunlight, few know how these rays are used in dentistry for curing diseased conditions of the mouth, for sterilizing the air in operating rooms, that in some hospitals two opposing ultra-violet sources are used to throw up a barrier across a corridor completely isolating one part of it, where infectious diseases are present, from the other.

The American Platinum Works division of the exhibit shows the use of platinum in crucibles and analytical apparatus used by the modern chemist. Here also is shown the application of iridio-platinum in tipping fountain pens and the latest machines that weld these tiny platinum tips in place.

At the exhibit of the Irvington Smelting Works the refining of gold and silver is of interest.

At the Johns-Manville building can be seen a series of exhibits that tell the story of how four of nature's minerals—asbestos, diatomaceous earth, limestone and asphalt have been transformed through research into hundreds of products.

Link Belt Co.'s exhibit is in the metals building. This exhibit portrays by working models, photo murals and colorful dioramas how industry can ease labor's burdens and at the same time expedite production and reduce costs.

Crane Co.'s industrial exhibit is housed in the Home Building Products Exhibit Building. It is one unit in a comprehensive display which includes plumbing and heating equipment in appropriate settings and a towering microscope focused on a transparent house in which the plumbing and heating systems are outlined.

Striking among the industrial exhibits is the huge igloo which symbolizes and houses the products of the Carrier Corporation of Syracuse, N. Y. This igloo, large enough to house a 5-story building, has snow encrusted walls and its own private Aurora Borealis which flashes on and off across the ceiling of the structure. The exhibit is air conditioned by one of the largest systems in the world, the "inner workings" of which are encased in glass.

The wonders of modern glass are depicted in a joint exhibit known as the Glass Center and sponsored by three of the country's leading glass manufacturers, Corning Glass Works, Owens-Illinois Glass Works and Pittsburgh Plate Glass Co. Two outstanding features of the glass center in addition to the multitudinous displays of the individual companies is a molten glass furnace in actual operation and a glass fibre making machine that produces the latest developments of the glass industry, the drawing of glass into "yarn" for fabrics.

Conclusions

In presenting these brief descriptions of some of the industrial exhibits at the Fair we have merely endeavored to indicate the type of exhibit which the companies associated with the power industry are showing. There are almost countless others which we have not touched upon but we hope that the discussion of these few will serve to define the pattern as a whole and that our comments will be taken in the constructive spirit in which they are offered. Whatever shortcomings the New York World's Fair may have in failing to measure up to the full expression of its theme are due not so much to the Fair as an organization but to the same general lack of coordination which makes the great difference between our haphazard world of today and the highly coordinated organization which will underlie the World of Tomorrow.

Heat Transfer in Brine Coolers as Affected by Operation

By John C. Consley[1]
Mechanical Engineering Department
York Ice Machinery Corp., York, Pa.

BECAUSE of the rapid decrease in heat transfer in plain tube flooded coolers at low brine velocities, low brine temperatures and low mean temperature differences, curves were prepared showing the effect produced by placing swirl strips in the tubes. The curves shown on Fig. 6 were plotted from tests on a flooded cooler with 2-in. O.D. tubes holding constant the specific gravity of brine (1.28 at 60 deg. F.) and a constant brine velocity of 200 ft. per min. These curves show the effect of swirl strips on heat transfer for variable average brine temperature at constant 9.5 deg. and 7 deg. M.T.D. respectively compared to similar curves for the same cooler without swirl strips. A comparison indicates that the swirl strips become more effective for either lower brine temperatures or greater M.T.D. or both.

In Fig. 7, the M.T.D. of 9.5 deg. F. and the average brine temperature of 15.5 deg. F. are held constant to show the effect of brine velocity on heat transfer for flooded 2-in. tube coolers, with and without swirl strips. The increase in heat transfer due to the use of swirl strips at 230 ft. per min. brine velocity is 8 per cent; but at 110 ft. per min. the increase is 65 per cent.

From a purely technical standpoint swirl strips seem to be advantageous even at high velocities, hence for the purpose of comparison we have shown on Fig. 7 a superimposed brine pressure drop curve for a 5-pass, 2-in. O.D. tube, 16-ft. long brine cooler with and without swirl strips. This indicates that the pumping head required for any given brine flow rate is definitely increased by the use of swirl strips and an economic balance must determine their usage.

Figure 8 shows a comparison in heat transfer between the spray type and flooded 2-in. O.D. tube coolers. In this series of tests on both coolers a brine concentration of 1.28 sp. gr. at 60 deg. F., a M.T.D. of 10 deg. F. and a brine velocity of 200 ft. per min. were held constant and the brine temperature was varied. The trend of variation in heat transfer with brine temperature is similar, the gain being slightly greater with brine temperatures in the spray type.

In a series of runs using the same coolers the average brine temperature was held constant at 20 deg. F., the brine velocity at 200 ft. per min., and the brine concentration at 1.28 sp. gr. at 60 deg. F. A similar series was secured on the 1¼ in. O.D. tube flooded cooler. Figure 9 shows for each cooler the variation in heat transfer with M.T.D.; the change having been obtained by varying the ammonia evaporating pressure. These comparative curves also show the difference in performance of these two types of coolers with varying M.T.D. The spray type cooler having a film flow of recirculated liquid refrigerant is to all practical purposes unaffected by a change in M.T.D.

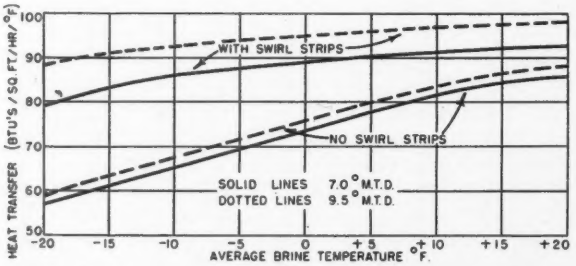


Fig. 6. Effect of swirl strips in tubes at various temperatures for 2 in. O.D. tubes at 200 ft. per min. and sp. gv. of 1.28

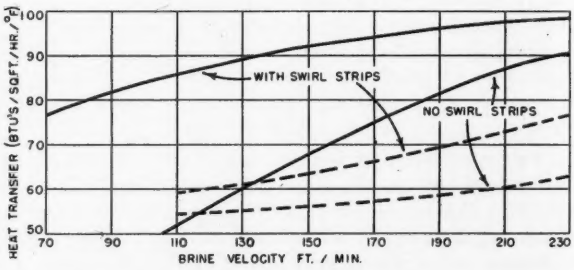


Fig. 7. Effect of swirl strips on heat transfer at various velocities with 2 in. tubes at 9.5 deg. F. M.T.D. and 15.5 deg. F. brine temperature and a sp. gv. of 1.28. The pressure loss curves are dotted and the scale in pounds per square inch begins at zero for the bottom line (50 deg. on the heat transfer scale) and increases 4 lb. for each square. The third line (corresponding to 80 B.t.u.) would be 12 lb. per sq. in.

Part I appears on Page 260 of the April 1939 issue of POWER PLANT ENGINEERING.

[1]From a paper presented before the 33rd Annual Meeting of the A. S. R. E.

Conversely, the flooded type, probably due to increased turbulence of the refrigerant with increased M.T.D., shows a marked increase in heat transfer. Increased turbulence may also partially account for the higher heat transfer in the 1¼ in. tube flooded cooler compared to the 2-in. tube flooded cooler. It is interesting to note that at 200 ft. per min. brine velocity and 20 deg. F. average brine temperature when the M.T.D. is above 12 deg. F., the heat transfer in the flooded type 1¼ in. O.D. tube cooler is above the heat transfer in the 2-in. O.D. tube spray type cooler.

While a study of Figs. 8 and 9 indicates higher heat transfer in spray type coolers than in the flooded type, particularly at low mean temperature differences, it must be remembered that they should not be compared commercially on a square foot basis. The cost per square foot of ammonia evaporating surface in a cooler depends on the ratio of the sum of the costs of shell, ammonia charge, recirculating pump, etc., to the cost of the tubes. This ratio does not vary the same with

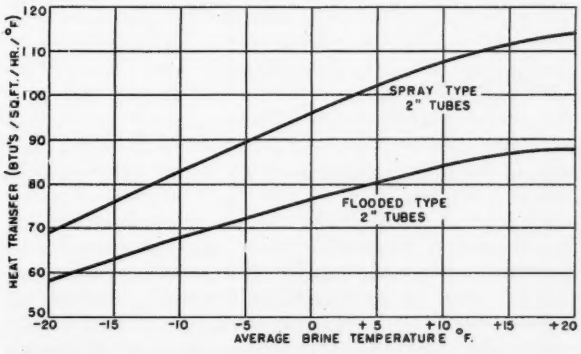


Fig. 8. Comparison of heat transfer at various temperatures in flooded vs. spray type brine coolers at velocity of 200 ft. per min., a M.T.D. of 10 deg. F. and a sp. gv. of 1.28

a change in capacity for the two types of coolers. Therefore an economic balance must determine the proper selection.

One other variable in flooded cooler performance is the effect of static head of liquid refrigerant on its evaporating temperature. While not usually important in the majority of commercial applications, in which the horizontal type of cooler is used, it does become increasingly important at low M.T.D.'s and low evaporating temperatures in large diameter coolers; so important sometimes as to indicate the desirability for the use of the spray type cooler to avoid the penalty thus imposed.

The tons of refrigeration calculated for a typical 60 in. by 16 ft. flooded cooler, assuming that the evaporating temperature corresponds to the refrigerant pressure at the cooler outlet and that the brine flow rate is 215 ft. per min. and brine is delivered at a temperature of —5 deg. F. would be about 93, 168, 246 and 333 t. respectively for 10, 9, 8 and 7 lb. pressure at the cooler outlet. The same cooler at the same operating conditions, except with the evaporating temperature is corrected for an increase in pressure equal to one-half the static height of refrigerant in the cooler would show a decrease in tons to 45, 122, 204 and 287 respectively for the same pressures.

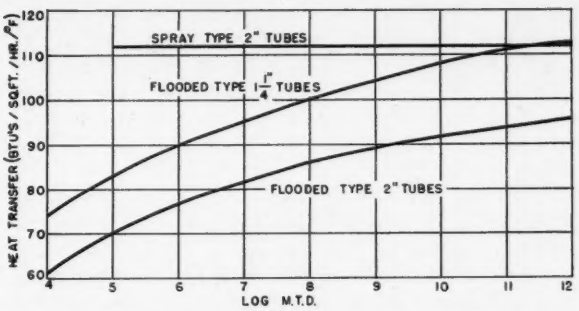


Fig. 9. Comparisons of performance of flooded and spray type coolers for various temperature differences. Brine temp. held at 20 deg. F., velocity 200 ft. per min. and sp. gv. 1.28

Figure 10 has been prepared for the double purpose of showing the importance of an exact knowledge of the heat transfer of brine coolers in some applications and to indicate the necessity for exact test data in determining their performance after installation.

It is assumed that a cooler is installed in a plant on a common suction main with other evaporators and variable compressor capacity to meet variations in load. The duty requires the delivery of —5 deg. F. brine and the brine pump has been installed to deliver a fixed quantity of brine at 215 ft. per min. velocity through the cooler. The heavy curve in Fig. 10 shows the tons of refrigeration that will be produced by this cooler when various pressures are maintained in the suction main.

Note from this curve marked "Cooler rating—true heat transfer" that if this cooler had been designed to operate at a highly economical evaporating suction pressure of 9 lb. per sq. in. gage the tonnage expected would be 30. If the suction pressure changes to 10 lb.

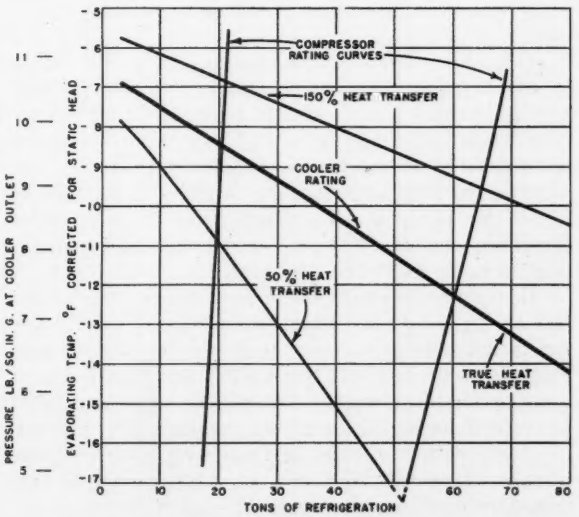


Fig. 10. Curve marked "Cooler rating—True heat transfer" shows the capacity of a brine cooler as a function of evaporator temperature for a brine velocity of 215 ft. per min., 1¼ in. O.D. tubes and an outlet temperature of —5 deg. F. and sp. gv. 1.28. The other two diagonal curves show the capacity with 50 per cent and 150 per cent heat transfer assumed. The nearly vertical lines are two compressor ratings at variable suction but constant speed and condenser pressure. An intersection of two curves shows the tonnage output for that combination of cooler and compressor (see text)

per sq. in., only 14 t. of refrigeration will be produced whereas if the suction pressure is 8 lb. per sq. in., 47 t. of refrigeration will be produced. Thus with plus or minus one pound change of pressure in the suction main the tons refrigeration produced would drop to 46.7 per cent or increase to 157 per cent of the intended design capacity.

Had the same cooler been designed to operate at 8 lb. per sq. in. pressure producing 47 t. of refrigeration, an increase to 9 lb. per sq. in. would reduce the tons produced to 30 t. of refrigeration, or 64 per cent; and a decease to 7 lb. per sq. in. would increase the tonnage to 65.5 or 139 per cent of the intended design capacity. The fallacy of nominal brine cooler ratings and the necessity for accurate measurements in determination of brine cooler capacity are clearly indicated in this curve.

In Fig. 10 hypothetical lines have been added which assume respectively that 50 per cent and 150 per cent of the true heat transfer is secured on the same brine cooler under the same operating conditions. The more steeply inclined lines are ratings in tons of refrigeration of standard ammonia compressors at varying suction pressures, but constant condensing pressure and constant speed. Any intersection then represents a balance point for that cooler and compressor under the stated operating conditions.

Assume that the cooler under consideration had been installed as a single evaporator connected to a compressor whose tonnage balances its capacity at a very highly economical evaporating temperature of —8.5 deg. F. The plant should then produce 20.6 t. of refrigeration. Note that a change to 50 per cent or 150 per cent of the true heat transfer value would cause a rebalance, as shown at the lower and upper intersections on the same compressor curve at 19.5 and 21.5 tons refrigeration, or a change of only about 5 per cent from the original calculated balanced tonnage.

The other compressor, the rating of which is shown to the extreme right of this figure, in combination with this same cooler, should produce 59.7 t. of refrigeration balancing at —12.3 deg. F. evaporating temperature. If the cooler produces only 50 per cent of expected heat transfer, the capacity is reduced to 51 tons or 14.5 per cent. Similarly if the heat transfer of the cooler is 150 per cent of that expected, the tons increase to 64 or 7 per cent.

In the first example there is evidence that on low M.T.D. installations inexact knowledge of heat transfer is not serious, as far as producing the desired result is concerned; but testing for heat transfer after installation is extremely difficult, since a very small error in determining brine temperature, or evaporating temperature, results in large percentage change in calculating M.T.D., therefore, a large error in heat transfer value calculated.

In the second example, because of higher M.T.D. inaccuracies in measurements of temperatures produce less percentage change in heat transfer, therefore testing is easier; however, inexact knowledge of true heat transfer is more disastrous in the application of a cooler to a job.

The multipass shell-and-tube cooler, utilizing evaporating ammonia in heat exchange with brine, has long been in commercial usage. There are many variables governing its performance. The data presented in this paper are the result of decades of experimentation under the supervision of experienced research engineers.

The coolers were operated under as nearly commercial conditions as it was possible to conceive. Results were carefully measured by means of accurate instruments carefully read and runs were periodically checked. The author has attempted to analyze and interpret these results for the purpose of presenting them in a readily usable form.

Industry Takes to Gas Engines

NINE REPRESENTATIVE MANUFACTURERS of gas engines reported to the A. G. A. the sale of 524 gas engine units representing 67,257 hp. in 1937, however, this was an increase of 77.5 per cent over 1936. With regard to the uses to which this gas-developed motive power is put: 10 per cent runs electric generators, 68 per cent operates air compressors, 2 per cent moves cotton gins and cottonseed oil mills, 5 per cent powers air conditioning and ice plants, and 15 per cent goes for pumping and other purposes.

From data supplied by gas companies, it was learned that in Southern California there is used between 400,000 and 500,000 hp. from internal combustion engines operating on gas fuel. Of this amount almost 100,000 hp. is used in industrial power applications, such as operating power machinery, refrigeration, ice manufacture, electric generation, and water pumping for domestic and agricultural uses. In the Southwest the use of gas in internal combustion engines is on an even greater scale.

Many of the new Diesel engine models are convertible to gas or can be offered for straight gas operation. Here is significant recognition of gas engine power by manufacturers who have previously built straight Diesel engines. Such equipment is finding excellent acceptance in territories where: (1) low year round gas prices prevail and therefore straight Diesel sales are difficult, and (2) low gas prices are available for part of the year (during the off-peak gas season) and gas can be used off-peak and oil on-peak by converting the engine.

It has been found that although it is possible to reclaim the "waste heat" from an internal combustion engine to the extent of 90 per cent, it is usually practicable to reclaim only from 50 per cent to 60 per cent of this heat. To obtain 90 per cent recovery nearly three times the heating surface is required as would be used to reclaim 50 per cent of the waste heat. The expense of the additional and more elaborate heat exchangers and water jacketing which would be required to recover 90 per cent, would, in most cases, be unwarranted economically in consideration of the low gas rates available for direct heating of water wherever gas engine operation proves to be an economical source of power. It has also been shown to be economical to make use of the waste heat in exhaust gases and engine jacket water for heating buildings and factories.

Clear and Warmer Furnace Atmosphere

A Discussion of the Causes and Effects of Furnace Temperature.

By G. Campbell Kohlar

FURNACE temperature is the fundamental factor influencing all furnace and boiler design. It affects the operation and the maintenance of everything from the burner to the stack, and a proper understanding of furnace temperature will do much towards relieving serious operating headaches, reducing investment costs, and pocketing maintenance dollars. But the calculation of this item is primarily the designers job, and it is he who must determine the size and shape of furnace which will give the best results under the required conditions. This being so, of what interest is the furnace temperature to the small industrial plant owner or the operating engineer? Once a boiler is erected what can be done about it?

Black and Gray Bodies

The temperature and the heat absorption in a boiler furnace are chiefly functions of radiant heat transfer, and some discussion of the theories underlying radiation may be of value. Radiant heat is considered to be a kind of wave vibration similar to light and radio waves. These waves require no medium for their transmission, and travel through space with the speed of light, 186,000 miles per second. The intensity of this radiant energy depends upon the temperature and the wave length. When the waves strike an obstruction of any kind, they are absorbed by the obstructing body or they bounce off. When all the radiation of all wave lengths which falls upon a body is absorbed by it, the absorbing body is known as a "black body". This has nothing to do with the actual color of the body, and a "black" body in this sense may really be white. A black body, besides absorbing all the radiation incident upon it, will also itself radiate; and the energy that such a body radiates is the absolute maximum that can possibly be radiated.

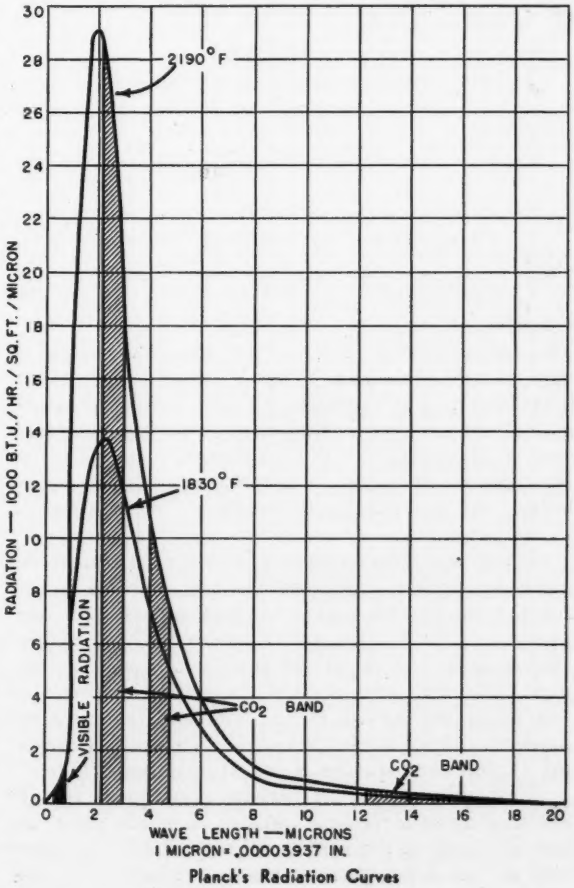
Black bodies are seldom found outside of a laboratory, and most of the radiating substances encountered in practice are not even "gray". A gray body is a body which will absorb a definite fraction of radiation of all wave lengths. Thus, if a "gray" body will absorb one half of the radiation incident upon it, the intensity curve will be geometrically similar to that of a black body at the same temperature, but it will be only half as high at any point. But most real substances will absorb nearly all incident radiation at some wave lengths, and little or none at other wave lengths. The problem is therefore quite complicated.

In the accompanying chart are shown two curves of the variation of the intensity of radiant energy with wave length, one for 2190 deg. F., and the other for 1830 deg. F. These curves were computed from Planck's Radiation Equation, a complex mathematical form which adds nothing to this discussion. The area under the curves between 0.4 and 0.8 microns is visible radiation; that is, the human optic nerve is sensible to radiation of these wave lengths and sees them as light. It will be seen readily how insignificant this area is in comparison with the entire area. Nearly all of the heat radiated in a furnace is at wave-lengths which are invisible, or infra red radiation. How then, is it possible by appearance to determine how hot a furnace is?

Variation of Radiation With Temperature

It will also be noticed that the intensity of radiation rises rapidly with the temperature. At 2190 deg. the maximum intensity is more than twice as much as it is at 1830 deg. This means that raising the temperature in a furnace from 1830 to 2190 deg. would give a tremendous increase in the rate of heat transfer, and yet there are many who still advocate limiting the heat release rate in a furnace to the point where 1800 deg. would be a very high temperature.

These curves, however, represent black body radiation, and consequently, not many practical furnaces will radiate according to them. A pulverized coal fired boiler is probably the nearest approach to black body conditions that can be found in practice. The millions of tiny particles suspended in the furnace are each radiating among themselves and to the surrounding surfaces with very effective results. Oil flames are



Planck's Radiation Curves

much less luminous than flames from burning coal, and gas flames are almost completely non-luminous. But oil and gas flames are rich in carbon dioxide and water vapor, both of which exhibit intense radiating powers over *selective wave lengths.* The cross-hatched bands in the figure are the wave lengths at which carbon dioxide will radiate. As the radiation temperature is reduced, the peak of the intensity curve shifts toward the higher wave lengths, and in so doing, tends to diminish the effectiveness of the radiation at the lower wave lengths. Note the difference in the carbon dioxide bands under the two curves on the chart.

The statements made in previous paragraphs that the greater portion of radiant heat was non-luminous, and also that pulverized fuel flames were excellent radiators because of their luminosity are apparently contradictory. The actual radiation of a non-luminous gas flame *is* much greater than the radiation from a luminous coal *flame* because the concentration of water vapor and carbon dioxide, the radiating constituents of furnace gases, is higher for a gas flame. But it is the suspended incandescent particles which make a flame luminous, and these particles are carbon. Porous carbon is almost a perfect black body, and it is because of these carbon particles—not to any properties of the flame itself—that a pulverized coal fired furnace is such an excellent radiator.

Computation of Heat Exchange

The classical method of computing the heat exchanged by radiation between two solid bodies is the Stefan-Boltzman Law:

$$Q = C\ A\ (T_2^4 - T_1^4)$$

Q = Heat exchanged between the two bodies.

C = "Stefan's Constant" or "Black Body Constant".

= 17.4 ÷ 10,000,000,000 B.t.u./sq. ft./hr./degree.[4]

A = Irradiated surface, sq. ft.

T_2 = Temperature of radiating surface, degrees absolute.

T_1 = Temperature of irradiated surface, degrees absolute.

This law is strictly true only for black bodies, but it may be applied to gray bodies by using a proportionality factor. For example, if a gray body will absorb half of the incident radiation upon it, 0.50 would be used in the equation. But, as has been mentioned before, nearly all bodies in practice are not even gray bodies, and the radiation "constant" is different for all temperatures.

It has been found that the furnace temperature depends upon four quantities, the heat released in the furnace, the sensible heat in the furnace gases, the temperature of the furnace walls that are receiving radiant heat, and the equivalent radiation constant of the furnace. The first two of these quantities are more or less under the control of the operator, the radiation constant is fixed by the furnace design, and the receiving surface temperature is relatively unimportant.

Heat released in the furnace per square foot of effective furnace cooling surface depends upon the steaming rate of the boiler. It is the total heat liberated by the combustion of the fuel plus the sensible heat of the preheated air, if any is used. From this must be subtracted the heat lost by "radiation" through the furnace walls to the surrounding atmosphere and the heat required for the evaporation of the moisture formed by the combustion of the hydrogen in the fuel. This factor can be controlled by regulating the steam output of the boiler. By "pushing" the boiler, more fuel will have to be burned with its attendant increased heat release. Operating a boiler at reduced ratings means a lower heat release, and therefore a lower furnace temperature.

Heat Absorbing Surfaces

The "effective furnace radiant heat absorbing surface" is a theoretical surface of flat steel plate, similar to the firebox of a locomotive boiler. Modern furnaces are not constructed in this manner, and the actual furnace wall area must be modified in some way. A bank of boiler tubes is considered to be equivalent to flat plate, and the actual projected area of such banks is used. Water-cooled walls of bare tubes or fin tubes are roughly 0.8 effective when clean, and about 0.5 effective when covered with slag. Refractory covered tubes may be taken as 0.4 effective, and the absorbing power of a refractory wall is zero. Thus, to find the "effective furnace radiant heat absorbing surface" it is necessary to find the actual projected area of each type of wall in the furnace, apply the proper correction factor, and add the various surfaces. It should be kept in mind that the correction factors given above are very approximate, but they are probably sufficiently accurate for any operating calculations.

The sensible heat in the furnace gases may be regulated to a certain degree by varying the excess air or by controlling the temperature of the preheated air entering the furnace. There is, of course, a definite amount of heat available from each pound of fuel, and increasing the excess air gives a greater weight of air to be heated and less heat per pound of gas.

It may be assumed with fair accuracy that radiant heat transfer bears some definite relation to the difference of the fourth powers of the absolute radiating and receiving surface temperatures. The receiving surface temperature is usually the temperature of the evaporating water in the furnace wall tubes and in the boiler tube bank, and it seldom exceeds 1000 deg. absolute. The mean radiating temperature—not the temperature of the gases leaving the furnace—is usually between 2500 and 3000 deg. absolute. The receiving temperature term is thus quite small when compared with the radiating temperature term, and has little effect upon the radiant heat transfer. Of course, if the pressure in the boiler drum is radically changed, or if the boiler and furnace are kept very clean, or are permitted to become excessively dirty and slag covered, the temperature of the receiving surface will change somewhat. But these could hardly be called conditions which are under the control of the operator.

The radiating constant of a given furnace is definitely fixed by the furnace construction and the kind of fuel fired. The term radiating "constant" is a decided misnomer because this quantity varies widely not only in different furnaces, but also in any given furnace under changing conditions. It depends upon the size

and shape of the furnace, the types of furnace wall surfaces and their location with respect to the fuel bed or flame, the thickness of the radiating gas layer and the concentration of water vapor and carbon dioxide in the gases, and numerous other conditions. The number and complexity of the component parts of this radiation variable makes it practically impossible to determine, so the quantity "equivalent emissivity" was invented. Equivalent emissivity is, in effect, a fraction obtained by dividing the actual radiant heat transfer in a furnace by the heat transfer that would take place if the furnace radiating and receiving bodies were both "black". This quantity can be determined by a combination of rational and empiric methods with sufficient accuracy for design calculations.

Calculation of Furnace Temperature

If then, the furnace temperature depends upon so many complex variables, how is it possible for anyone who has no access to an enormous amount of scientific and experimental data to compute it? Fortunately, there are a number of empiric formulas in the literature of the subject, by which the furnace temperature may be found with a minimum of mathematics. Perhaps the best and most useful of these empiricisms is that of George Orrok:

$$M = \frac{1}{1 + \frac{A}{27}\sqrt{C_r}}$$

where

M = fraction of total actually liberated sensible heat absorbed as radiation.
A = pounds of air per pound of coal
C_r = pounds of good bituminous coal per square foot of projected surface exposed to radiation.

For fuels other than bituminous coal, Orrok has modified his formula as follows:

$$M = \frac{1}{1 + \frac{A}{25}\sqrt{F_r}}$$

F_r = pounds of combustible in the fuel fired per hour per square foot of projected radiant surface.
Other terms as above.

Application to Specific Problem

As an example, assume a four drum bent tube boiler 20 sections wide, having a bridge wall of refractory covered tubes 10 ft. high, and 21, 3¼ in. bare tubes on 6 in. centers by 10 ft. long in each side wall. Suppose this boiler to be fired with 5000 lb. per hour of bituminous coal having 13,000 B.t.u. per lb., and 12½ lb. of air per pound of coal. The projected surface exposed to radiation would be:

Boiler tube bank	say $25 \times 10 \times 1.0$	$= 250$
Bridgewall	$10 \times 10 \times 0.4$	$= 40$
Two Sidewalls	$10 \times 10 \times 0.5 \times 2$	$= 100$
	Total effective surface.....	390

The factors 1.0, 0.4, and 0.5 are used for converting actual projected area into "effective surface".

$C_r = 5000 \div 390 = 12.8$
$A = 12.5$

$$M = \frac{1}{1 + \frac{12.5}{27}\sqrt{12.8}} = \frac{1}{1 + 1.66} = 0.375$$

That is, 0.375, or ⅜, of the heat actually liberated in the furnace is absorbed radiantly, and the remaining ⅝ is contained in the gases leaving the furnace.

The heat content of the fuel is $5000 \times 13{,}000 = 65$ million B.t.u. per hr. But perhaps 5 per cent of this heat is lost in radiation to the surrounding air, evaporation of moisture in the fuel, and unburned carbon in the fuel.† This leaves 61.75 million B.t.u. available in the furnace gases. Each pound of coal is burned with 12½ lb. of air, making $5000 \times 13.5 = 67{,}500$ lb. of furnace gas. If the specific heat of the gas from room temperature to the furnace exit gas temperature is 0.27 then,

$$\frac{61{,}750{,}000 \times .625}{67{,}500 \times .27} = 2120 \text{ deg. F.}$$

If preheated air at 250 deg. F. were used instead of cold air, the available heat would be increased by $5000 \times 12.5 \times 0.24\ (250 - 80) = 2.55$ million B.t.u. and the furnace exit temperature would then be

$$\frac{64{,}300{,}000 \times .625}{67{,}500 \times .27} = 2220 \text{ deg. F.}$$

(In this calculation, 0.24 is taken as the specific heat of air.)

Interpretation for the Operator

Up to this point, the theoretical and design features of furnace temperature have been mentioned, and we will now turn to an interpretation of these facts from the operator's point of view. The preceding example clearly shows the effect of preheated air on furnace temperature, and the temperature of the preheated air is decidedly under the control of the operating engineer. The amount of excess air is also under his control, and this too has an important effect on the furnace temperature; 12½ lb. of air represents roughly 30 per cent excess air; if this were reduced to 20 per cent, or about 11½ lb. of air per pound of coal, the fraction of the heat absorbed radiantly in the furnace would increase from 0.375 to 0.395. This is not enough to compensate for the reduced weight of gases, and the exit temperature would rise from 2120 to 2220 deg. according to Orrok's equation.

Thus, for any given firing rate, the operator has the power to vary the furnace temperature by more than 100 deg. Equipment for accurately measuring the temperature of a furnace is seldom standard in the average power plant, so that even if the operator can vary this temperature somewhat, he can only guess as to how much it has changed. It is therefore very important that the manufacturer's recommendations in regard to excess air and temperature of preheated air be closely followed. Quite often a furnace tempera-

†For an accurate method of treating unburned carbon losses, and computing the actual weight of the products of combustion, see "Effects of Unburned Combustible", page 299, May 1938, Power Plant Engineering.

ture 100 deg. above that for which the furnace was designed has led to serious difficulties from slagging, low superheat, and poor efficiency.

In a coal fired furnace the ash will fuse and form a plastic, running slag upon the walls. The quantity of slag depends upon the characteristics of the coal, the type of firing, whether pulverized fuel or stoker, and the furnace temperature. This slag does no particular harm, since it is expected and provided for. As a matter of fact, slag is sometimes caused to form a kind of refractory protection for furnace wall tubes. But if slag accumulates in the boiler tube bank or on the superheater tubes it becomes a nuisance, and even a menace to good operation. The passage of the gases through the boiler is obstructed, and the gas distribution is erratic and uneven. Convection heat transfer to the boiler tubes and the superheater is inhibited, and excessive quantities of dirt and fly ash will go up the stack. To prevent such adverse conditions it is essential that the temperature of the gases leaving the furnace be below the fusing temperature of the ash in the coal.

Ash Fusion Temperature

Manufacturers always specify the minimum ash fusion temperature that will give satisfactory results, and this minimum should be strictly observed. If a plant owner has a boiler built with the understanding that he will never use coal having an ash fusion of less than 2500 deg., he should never use a "bargain" coal having a fusion temperature of, say, 2100 deg. Such a policy would be suicidal, and more money would be spent for cleaning and reconditioning the boiler than would be saved by purchasing the cheaper coal. It would be equally inadvisable for a plant owner to specify that his furnace be capable of burning 1900 deg. ash fusion coal when he is perfectly certain that only on very rare occasions will he ever use a coal having a fusion temperature below 2300 deg. Other factors being equal, a furnace that will efficiently burn a low ash fusion temperature coal is more costly than one intended for a coal of higher ash fusion.

The ash fusion temperature of the coal then, is the only limit of the permissible furnace temperature in a coal fired unit. With the proper coals, very high liberations are possible, and excellent efficiencies may be obtained. It must be understood, however, that a plant which is designed for burning high grade coals exclusively is operating under a handicap. A shortage of the particular coal required leaves such a plant helpless, and it also eliminates any possibility of bargaining for fuel.

Furnaces in which oil or natural gas is the principal fuel are limited in temperature only by the refractory walls. It has been found from experience that 2500 deg. is about the highest temperature that is economically practicable. Above this point, refractory maintenance becomes excessive. If the furnace is completely water cooled, refractory maintenance is no longer of any consequence, and the furnace temperature may be as high as is consistent with efficient combustion.

If the ash fusion temperature of the coal, or the maintenance of refractories does not limit the furnace temperature, the only other consideration is that the fuel must have "room to burn". No hard and fast general rule can be set up for this requirement, and the only safe guide must be the manufacturer's experience. Burners should be placed in such a manner that the flame does not impinge upon the furnace walls and that the flames of adjacent burners do not interfere with each other. Stokers must be set so that correct mixture and combustion of gases is obtained. Quite often statements are made to the effect that the allowable liberation in an oil burning furnace, for example, is from "30,000 to 60,000" B.t.u. per cu. ft. When must the 30,000 figure be maintained, and when is it permissible to go to 60,000? Statements of this type are usually based upon statistics from a number of plants of various sizes and which operate under a wide variety of conditions. It is impossible to apply any such broad rule of thumb to an individual installation.

Furnace Proportions

Liberations in B.t.u. per cu. ft. of furnace volume or per foot of furnace width are only rough guides to efficient furnace operation. Another glorious old catchword is "Cubic feet of furnace per developed horsepower". As a guide in designing an efficient furnace this is sheer nonsense. Liberation in B.t.u. per foot of furnace width is of some value as an indication of the velocity of the gases through the furnace. A narrow furnace means high gas velocities, which in turn mean stratification and short circuiting portions of the unit. B.t.u. per cu. ft. is a rough indication of furnace temperature, but it is a fact that if burners could be adjusted with micrometric fineness, and could be assured of the constant loving care and tenderness of a very capable operator, furnace liberations twice as large as those now commonly found would not be impossible.

A certain large city recently had, and still may have, an ordinance requiring "three cubic feet of furnace volume for each developed horsepower" on all pulverized coal furnaces. A developed horsepower is equivalent to 33,475 B.t.u., and assuming an efficiency of 80 per cent, which is low for a modern water-cooled pulverized fuel installation, this would mean a liberation of

$$\frac{33{,}475}{3 \times .8} = 13{,}950 \text{ B.t.u. per cu. ft.}$$

whereas units of this type usually have liberations in the neighborhood of 30,000 B.t.u. per cu. ft. A liberation as low as 14,000 indicates a furnace temperature of about 1800 deg., and few coals now used in the United States have fusion temperatures below 2100 deg. This ordinance means that the initial cost of a pulverized fuel plant would be far above what it ought to be.

There was also an ordinance requiring all oil fired furnaces to have a volume of 1½ cu. ft. per developed horsepower. With such a low liberation the temperature in an all refractory furnace would be less than 2400 deg., and in a completely water-cooled furnace the temperature would not exceed 2000 deg.

The art of furnace design has today progressed to the point where objectionable smoking and fly ash are almost, if not entirely, eliminated. Operation in strict accordance with the conditions for which a unit was designed is the only necessary guide.

The Small Power Plant

From a comprehensive background of experience the author discusses, before the Midwest Power Conference, the small power plant, from the standpoint of small utilities, municipalities and universities

By G. A. GAFFERT,
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GREAT STRIDES have been made in the technical development of both large and small stations in the last ten years. Probably the most significant change affecting all sizes of plants is that relating to fixed charges. Not many years ago, the production cost was very nearly the same as the fixed charges, but this ratio has now changed so that 60 per cent for fixed charges and 40 per cent for production costs is more representative.

If we consider that a small utility is limited to turbine unit sizes below 10,000 kw. and that unit sizes are more frequently in the order of 2000 to 5000 kw. our field is fairly well defined for the present discussion. Throttle pressures up to 450 lb. and temperatures up to 750 deg. F. have become basic design conditions. Any departure from this standard has to be justified by an economic study.

Fortunately, the operating temperature affects only the superheater in the boiler, the main steam pipe lines, and the high pressure end of the main turbine. Engineering requirements do not call for the use of alloy steel at 750 deg. F. because of stress or creep limitations. However, initial temperatures up to 825 deg. F. are being considered in certain cases where the unit size is 5000 kw. or above and where fuel costs are high. A study of these comparative conditions for which plant heat rates are shown in Fig. 1, indicates that it takes ten years to pay for the higher pressure and temperature conditions with 5000 kw. units, $3.00 per t. coal, and with a 50 per cent load factor.

A unit of 10,000 kw. capacity is of sufficient size to warrant consideration of 600 lb. and 825 deg. F. design conditions, particularly when future station growth is considered. Fuel economy demands three feed water heaters in the average small plant, although two heaters can only be justified in certain cases. The standard cycle involves one low pressure heater and the mixing or deaerating heater. A third, or high pressure heater, if justified, would heat the boiler feedwater from 275 to 325 deg. F.

It may be of some interest to review the possible efficiencies of turbine and steam generating equipment at this point. Figure 1 shows the variation of turbine efficiency and cost with unit size. In this low capacity range, efficiency improves much more rapidly per 1000 kw. than in the larger sizes and definitely indicates the advisability of selecting as large a unit as can economically be fitted to the load curve. The cost of steam generating units suitable for turbines of this capacity range will vary somewhat as shown in the same figure. Another curve shows approximate full load plant heat rates, obtainable for stations up to 10,000 kw. capacity using modern turbines and steam generating units equipped with heat recovery devices. Considerable thought should be given to selecting the appropriate turbine size, since 35 to 40 per cent of the complete plant cost is thereby established at once in a unit plan. Table I is a typical cost allocation for a small utility plant located remotely from its load.

Modern boilers have improved in availability, particularly where water cooled furnaces are employed. Boilers should not have to be taken off the line today except for scheduled periods, and the latter can be made to coincide with low load periods. Consequently, a two unit turbine plant with three boilers has become

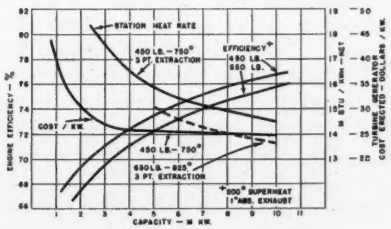


Fig. 1. (Left) Station heat rates, engine efficiency and equipment costs as a function of size and steam pressure

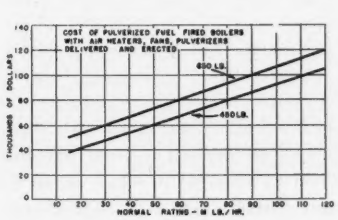
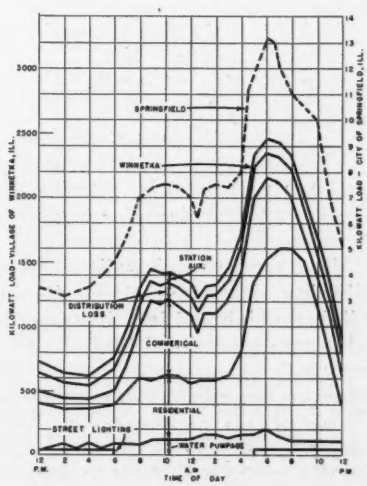

COST OF PULVERIZED FUEL FIRED BOILERS WITH AIR HEATERS, FANS, PULVERIZERS DELIVERED AND ERECTED
650 LB.
450 LB.
THOUSANDS OF DOLLARS
NORMAL RATING — M LB. / HR.

Fig. 2. Typical composite load curves of the City of Winnetka, Ill.



standard practice in the past, but there is now a growing tendency toward a one turbine-one steam generator plant.

Even with cheap fuel available a boiler efficiency of 80 per cent is economically sound, and 85 per cent is advisable with base load and high fuel cost. The method of firing is entirely dependent upon local conditions. Stoker firing is still favored in densely populated locations, since pulverized fuel with the necessary fly ash collection is rather costly for a small plant. Where the fly ash nuisance is not of great importance, pulverized fuel is being quite universally applied.

It cannot be emphasized too strongly that fitting the type and size of turbine to a load curve must

Table I. Approximate Percentage Cost Allocation for a Small Plant With a Concrete Substructure and Selected Common Red Brick Superstructure

Land and Improvements	3.00
Building	9.00
Circulating Water Intake	3.00
Main Piping	6.00
Draft System, Boilers and Accessories	12.50
Feedwater System	2.00
Coal and Ash Handling	7.00
Turbine and Condensing Plant	28.00
Main Electrical Equipment	4.00
Auxiliary Electrical Equipment	3.00
Substation	7.50
Miscellaneous Equipment—Construction Expense	3.50
Engineering	7.00
Supervising and Field Work	4.50
Total	100.00

be given careful consideration. Capacity factor and steam saving must be balanced against relative capital costs of various unit sizes. Consideration also has to be given to the annual rate of growth as it is important to lengthen out the period between plant extensions. Recent studies have indicated that rates of annual load increase vary between 5 and 10 per cent. Also, at least a 10 year load growth should be analyzed to arrive at the proper combination for the least total annual operating costs. In an effort to reduce initial capital investment, several innovations* have been applied to small utility plants as follows:

1. The firing aisle is located between the boilers and the turbine room, and no curtain wall is used between them.
2. There are no separate switchroom facilities.
3. All boiler and turbine operation is from one central group on one floor level.
4. Centralization of generator and outgoing feeder controls is advised.
5. All heaters and pumps are closely grouped in order of cycle arrangement to reduce piping.
6. Use is made of 4 in. exterior brick walls and precast concrete slabs for roofs and temporary end walls.

The average municipality load curve involves the following elements: Street lighting and municipal buildings; high and low lift water pumpage; residential usage; commercial load.

*The original paper of which this is but an abstract had reference to three plants: the Knife River Station of the No. Dak. Power & Light Co., Woodcock Station of the Central Ohio Light & Power Co., and the Winnetka (Ill.) station. Woodcock Station was described on page 618 of het October, 1938, issue; the Winnetka Station will be described in the near future. Study of these articles will show the practical application of many of the points brought out in this summary.

A composite load curve for the village of Winnetka is shown in Fig. 2. Peak loads on municipal systems tend to occur on holidays in the winter season, when residence use is at a maximum. The load factor is usually low, in the order of 40 to 50 per cent, but the power factor is usually high. If the plant is an isolated one, every reasonable precaution should be taken to provide continuity of service in duplicate or steam driven auxiliary equipment. Also, allowance must be made for outage on the largest boiler or turbine at the time of the peak.

The average size Midwestern University has an electrical peak load of from 1500 to 4000 kw., but it has a steam heating load that is considerably larger than that required for generation of power purposes. In fact, the steam heating load may have no apparent relation to the power load.

There are three general approaches to the problem of providing adequate heating and power requirements: Purchase all power and provide heating steam facilities only; purchase all power in excess of actual

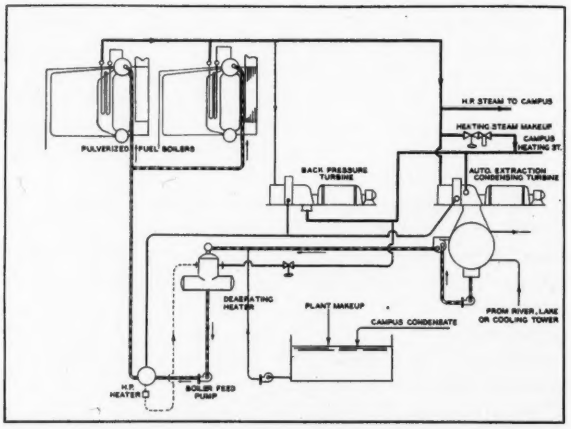


Fig. 3. Typical flow diagram for an isolated university power plant which can be built for from $120 to $140 per kw.

heating steam equivalent requirements; provide an isolated plant for all power and heating requirements.

The third scheme of an isolated plant is somewhat like a small utility plant. Facilities must be provided for condensing power to balance heat and power demands, and for adequate steam supply for campus heating. Campus heating steam supply pressure will vary seasonably, and the non-condensing type of turbine will normally carry the electrical load by acting as a reducing valve for the heating system. Some 75 per cent of the total annual power may be produced in this manner and it is very cheap power.

The automatic extraction machine gives an opportunity to balance the load and heat requirements without steam waste during the spring and fall seasons. It is difficult to justify throttle pressures over 400 lb. unless the electrical load is high in comparison to the heating load. Figure 3 shows a typical flow diagram for an isolated plant. Plants of this type can be built for $4.00 to $5.00 per lb. of installed steam capacity or $120.00 to $140.00 per kw. when all essential equipment and auxiliaries are considered.

Part I. Operating instruments in a modern steam power plant are used for measuring, recording and integrating factors affecting operating conditions. This part of a series of two articles enumerates the entire selection of instruments for a modern, small, central station plant and gives pertinent information on some of the principal instruments. Part II will give details of how the readings are gathered and recorded.

Power Plant Instruments and Records

By RICHARD W. CRAIN,

Instructor in Mechanical Engineering,
University of Washington.

IN ORDER that a power plant may give good, uninterrupted service, it is necessary that it be under careful observation at all times. In so doing, it is possible to improve the conditions under which it operates and to increase its efficiency and money earning power. Modern instrumentation and record keeping have, to a great degree, solved this problem that faces the steam power plant of today—this day and age of great and close competition.

In discussing this interesting and important subject, a modern steam power plant is used for illustration. Table I gives the principal equipment in the plant which will serve to indicate the size of the plant. Table II lists the instruments in the plant, giving an idea of the great extent to which the plant uses instruments and records. Figure 4 is a sketch showing the location of all instruments in the plant.

Instruments in a steam power plant are used for measuring, recording, and integrating the factors of operation. Instruments would be of little value if they were not read regularly, the readings recorded in permanent form, and used to benefit the plant in some way. If the records kept are used to check on performance and efficiency of the apparatus, to insure safe and proper service and condition of the equipment, and to show ways and means toward more economical operation, then the instrumentation and record keeping of the plant will greatly benefit all.

TABLE I—PRINCIPAL EQUIPMENT IN THE PLANT

Steam Generator	Two Combustion Engineering Co. bent water tube boilers—395 b.hp.—430 lb. per sq. in. wk. Pr.—25000 lb. st. per hr. Detroit Rotostokers. Forced and Induced draft. American Blower Co. Fans.
Turbo-Generators	Two—Westinghouse Reaction Turbine—2500 h.p.—3600 r.p.m.—13 lb. st. per kw. Westinghouse a.c. generator—1500 kw. (1875 kv.-a. at 80 per cent P.F.)
Condenser and Air Ejectors	Two—Elliot Co. Condenser—2300 sq. ft. Elliot Co. air ejectors—45 lb. air and water vapor per hr. at 1 in. absolute vacuum.—180 lb. st. per hr.—300 lb. per sq. in. pres. Back pres. 1 lb.

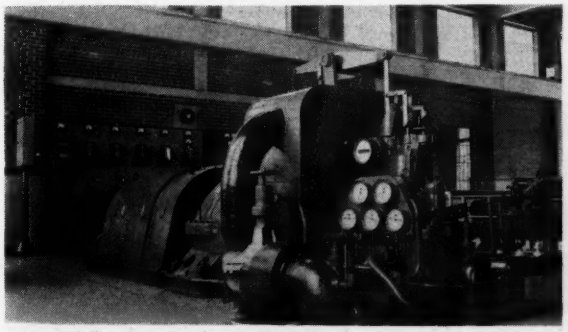


Fig. 1. One of the 1500 kw. turbo-generator units

Practically all of the pressure gages in the plant are of the Bourdon-tube type, in which the pressure in the apparatus tends to straighten a bronze tube thus moving the pointer to the correct pressure reading. All temperatures on the apparatus are determined by standard mercury column thermometers. The feedwater entering the boiler is regulated by a Copes feedwater regulator, Figs. 5 and 6.

Flow meters for both steam and water which are the intergrators, the strip chart recorder and the

TABLE II—INSTRUMENTS INSTALLED IN PLANT

I. INSTRUMENTS IN CONNECTION WITH STEAM GENERATOR

A. Miscellaneous

2—Bourdon-tube steam gages on front of boilers.
1—Coal weight recorder on traveling weigh larry.
2—Automatic coal regulators beside the stokers on front of boilers.
2 pair controls—(forced draft, induced draft and damper regulators).
2 sets pressure gages and thermometers (3 gages and thermometers) steam pressure and temperatures at feedwater heaters.
2 sets thermometers (3) temperatures of feedwater in feedwater heaters.
1—Make-up water meter, gage board and surge tank.
1—Steam gage. Pressure of superheated steam in main loop headers.
1—Thermometer—Temperature of superheated steam at superheater outlet at boiler.
1 Pressure gage—feedwater into boiler feed pumps.
1—Pressure gage—feedwater out of boiler feed pumps.
1—Thermometer—temperature of inlet air into forced draft fans.
2—CO_2 Orsat apparatus.
2—Copes feedwater regulator on side of boilers at top.
2—Steam flow meters.

B. On the Boiler Panel.

3—Starting and stopping switches, and speed regulator handles for three boiler feed pumps.
2—Multi-point indicators for combustion factors of the two steam generators which indicate:
- Steam flow
- Per cent CO_2
- Drafts (last pass, induced; furnace; two plenum chambers; forced.)

2—Six-pen strip chart recorders which record:
- Steam flow
- Steam temperature
- Uptake temperature
- Per cent CO_2
- Steam pressure

2—Integrating meters, pounds of steam evaporated by each boiler.
2—Handles for placing induced draft fan on hand control or automatic.
2—Handles for operating the reversing switch for changing the speed of the induced draft fan when on hand control.
2—Switches turn on and off the induced draft fans.
2—Switches turn on and off the boiler stoker motors.
2—Switches turn on and off the forced draft fans.
1—Two-point indicator which indicates:
- Steam pressure on boiler
- Feedwater pressure at boiler feed pump discharge.

2—Mercury columns indicate air entering each boiler.
1—Mercury column indicates the coal entering the boiler (expressed by a pressure in inches of mercury).
1—Master controller which permits automatic or manual control of the boilers, consisting of:
- Four levers or hand wheels } Two pressure gages }
  - Used in switching from automatic to manual control and back again, and in operating the boiler manually.

II. INSTRUMENTS IN CONNECTION WITH TURBO-GENERATOR

A. Miscellaneous

4—Pressure gages—circulating water in and out of condensers, oil coolers and generator air coolers.
4—Thermometers—temperature of circulating water in and out of condensers.
2—Meters—condensate flow from condenser to boiler.
1—Meter—city water into plant.
8—Thermometers—temperatures of oil in and out of oil coolers and of air in and out of generator air coolers.
4—Thermometers—temperatures of circulating water leaving oil coolers and generator air coolers.
2—Pressure gages—condensate leaving condenser (discharge of condensate pump).
2—Tachometers (vibrating-one on each turbine)—show r.p.m. of turbines.
10—Pressure gages (5 on each turbine)—show throttle pressures, bleed steam pressures (high and low), vacuum on condensers.
4—Thermometers (2 on each turbine)—temperatures of steam at throttle and exhaust.
4—Pressure gages (2 on each turbine)—pressures of lubricating oil and of steam operating small, vertical turbine of auxiliary oil pump.
2—Vacuum gages—vacuums on each air ejector.

B. On Turbine Panel are:

1—Telechron electric clock and master clock for the entire city and for the correct speed of the generator.
2—Multi-point indicators for operation factors of the two turbines which indicate:
- Turbine throttle pressure.
- Temperature—circulating water to condenser.
  - —circulating water from condenser.
  - —air to generator air coolers.
  - —air from generator air coolers.

2—Integrating meters—pounds of feedwater flow to boilers.

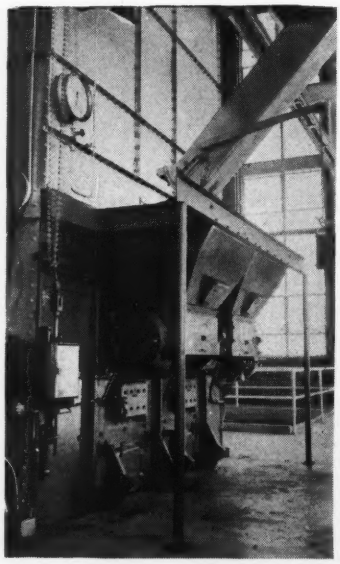


Fig. 2. Steam generating unit served by spread type stoker

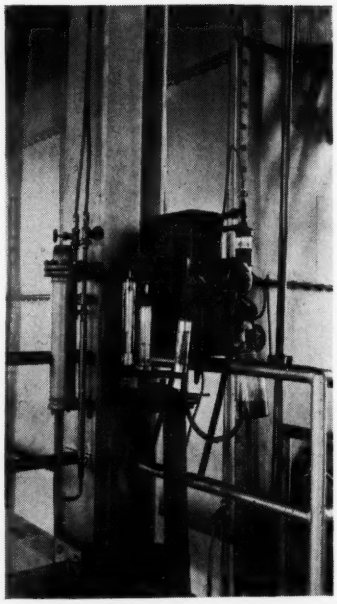


Fig. 3. CO_2 sampler apparatus and meter body (left) for electrically measuring flow of steam or water

2—Integrating meters—pounds of steam going to turbines.
2—Six-pen strip chart recorders which record:
- Circulating water flow—each condenser
- Temperature—in coming circulating water
  - —circulating water out of each condenser
  - —exhaust steam each turbine
  - —feedwater
- Steam flow to each turbine
- Feedwater flow to each boiler

1—Two-point indicator which records:
- Boiler feed suction header pressure—pounds
- Altitute gage—feet of water

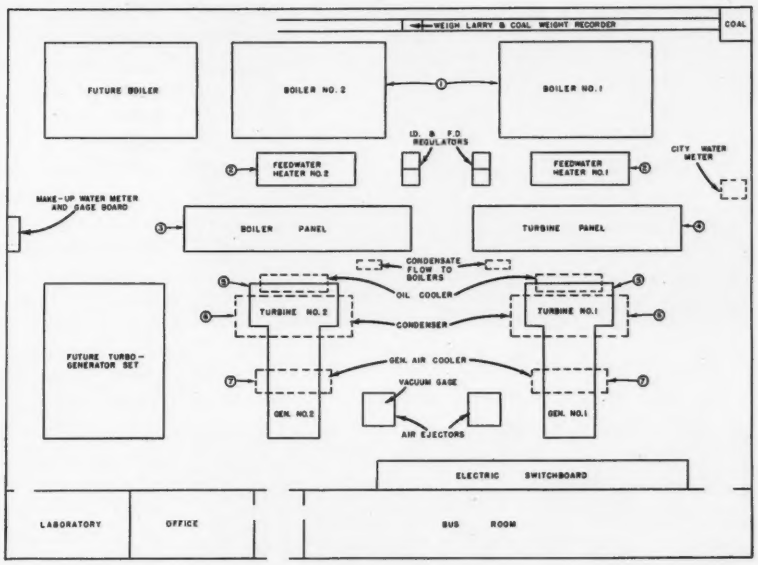
1—Wheatstone bridge recorder which indicates the condition of the water (condensate and make-up) in the condenser as to hardness and impurities.
2—Mercury columns—pressure of atmosphere (barometer) and vacuum on condenser.

C. On Electrical Switchboard are:

8—Ammeters—a.c. amperes for each generator and each circuit.
1—Voltage recorder—a.c. volts.
7—Kw-hr. meters—kw-hr. for each generator and each circuit.
1—Power factor meter.
2—Rheostats—a.c. voltage regulation each generator.
2—Meters—generator temperatures.
2—Meters—a.c. kw. indicators.
2—Meters—d.c. volts each exciter.
2—Meters—d.c. amperes each exciter.
2—Voltage speed regulators.
—Test blocks, phase current contactors, current relays, operating lever and circuit breakers for each generator and circuit.
4—Synchronism switches (2 each generator).
2—Generator speed (cycles, r.p.m.) regulators (one each unit).
1—Kilowatt recording meter.
1—Synchroscope.
2—Meters—a.c. volts each generator.
1—Meter—cycles on generator.

Fig. 4. Location of Instruments in Power Plant

1. Steam gages—Saturated, front of boiler; superheated steam, main steam header. Coal regulator. CO_2 apparatus second floor.
2. Pressures and temperatures of steam and feedwater.
3. Steam flow, pressure and temperature. Flue gas temperature. CO_2 per cent. Drafts. Feedwater pressure. Air and coal into boiler furnace.
4. Master clock. Turbine steam pressure and flow. Feedwater flow. Temperatures—circulating water, generator air, exhaust steam, feedwater.
5. Turbine throttle steam pressure. Bleed steam pressure. Vacuum. Temperatures of steam at throttle and exhaust.
6. Pressures—condensate out of condenser, circulating water in and out of condensers and oil cooler. Temperatures—circulating water in and out of condensers, circulating water out of oil-cooler, oil in and out of oil cooler.
7. Pressures—circulating water in and out of generator air coolers. Temperatures—circulating water out of generator air coolers, air in and out of generator air coolers.



multi-point indicators, are all operated electrically. Measuring flow by electricity requires the use of an orifice plate with differential pressure connections to the meter body shown in Fig. 7 and also in the left of the picture, Fig. 3. An orifice plate made of monel metal, stainless steel or bronze, is placed between flanges in the pipe where the flow is restricted and measured. This causes a pressure difference on each side of the orifice which is proportional to the square of the velocity. Diagrammatically this effect is shown in Fig. 7. This difference in pressure is used to measure the rate of flow by a manometer, or U-tube, connected to properly spaced pipes on each side of the orifice. The differential pressure is balanced by mercury in the U-tube. This tube goes down the outside of the body, up through the bottom of the meter body and into the bottom of the contact chamber inside the body, as shown in Fig. 7. The

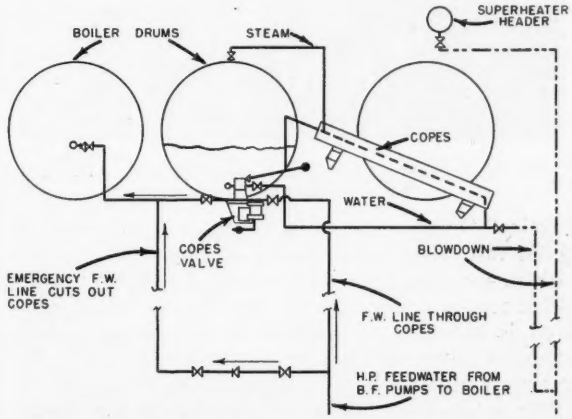


Fig. 5. Diagram illustrating principles of feedwater regulator

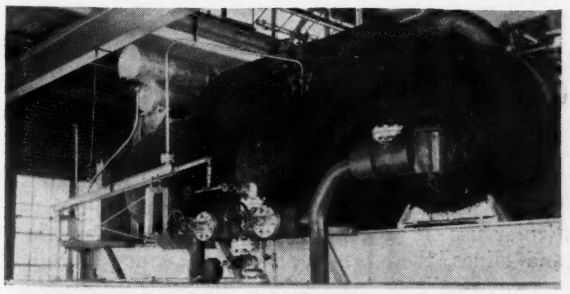


Fig. 6. Feedwater regulator as installed

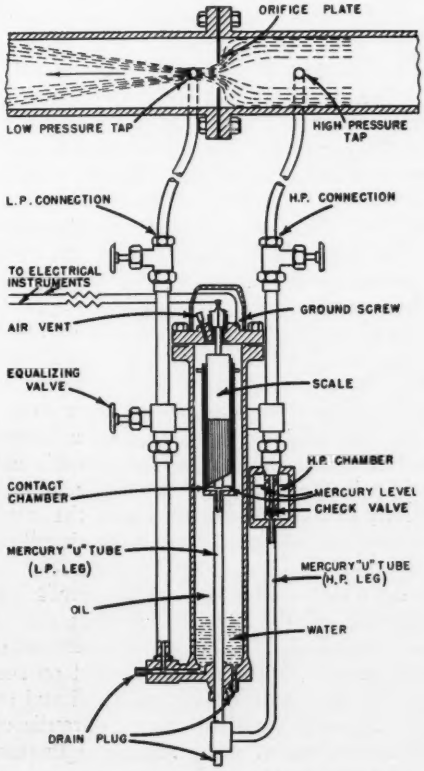


Fig. 7. Diagram illustrating the principles of measuring flow by electricity

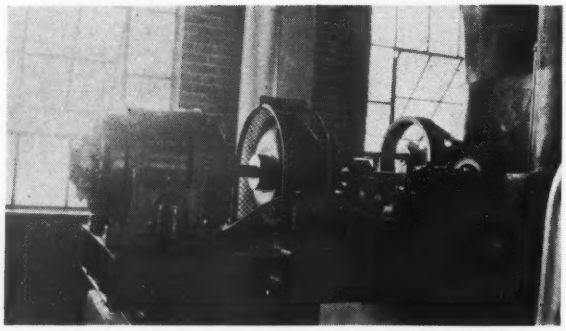


Fig. 8. Induction draft fan with hydraulic coupling

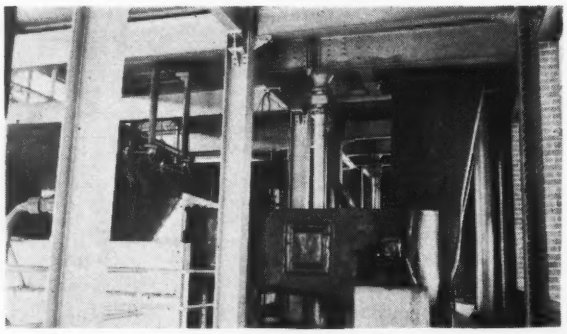


Fig. 9. View of boiler breeching

bottom of the meter body has water in it up to the level shown in the figure. At the bottom of the body to this water space is connected the other part of the U-tube which is filled with water up to its connection to the flow pipe on the opposite side of the orifice. The inside of the body above the water is filled with oil which also fills the contact chamber down to the mercury. The oil is there to seal in the mercury so it does not oxidize. As the mercury level rises in the contact chamber by force of the high pressure from the flow pipe down on the mercury in the U-tube, it contacts chrome-steel rod resistances which are stepped to suitable lengths. As the mercury rises on these contact rods more current flows to the panel boards where it is translated to rate of flow and total flow. Here also a transformer steps down the voltage to 40 v. for the instrument circuits. The indicator and recorder which show rate of flow as lb. per hr., gal. per min. etc., are similar to ammeters, the current flowing in the circuit actuating them. The instruments measure the conductance of the circuit, so the integrator reads the summation of the instantaneous conduction of the circuit over any period of time.

Figures 8 and 9 show the induced draft fan beside the breaching of the boiler. There is an eccentric roller on the end of the shaft which makes and breaks a contact thereby causing the red light on the boiler panel on the operating floor to flash off and on. The speed of the fan is regulated by a hydraulic coupling between the induction motor shaft and the fan shaft. With the fan running under automatic-control and the speed of the fan decreasing as by necessity, a pump delivers more oil into the coupling which acts to slow down the fan shaft, the motor shaft staying at a constant speed. When the fan is on hand control, the speed is changed by the hand lever shown on the boiler panel. Either automatic operation or hand operation works a reversing switch or speed control switch on the back of the boiler panel. As this switch makes and breaks contact it operates the oil pump on the fan causing less or more oil to flow into the coupling, as the case may be.

Induced and forced draft fans are regulated by air-controlled Smoot control regulators, Fig. 10, one for each fan working in conjunction with each other. They regulate to cause as nearly as possible zero draft in the last pass of the boiler and in the furnace above the fire. The forced draft and plenum chambers drafts then give the fire its correct amount of air and draft. These regulators are operated by compressed air through a pilot valve into a sylphon bellows or diaphragm made of leather, oil-impregnated to prevent air leakage. As a balanced weigh beam becomes unbalanced due to change in draft, the beam works a multiplying valve which changes the amount of air in the diaphragm. The diaphragm, in turn, moves a dash pot and plunger, termed the amplifier,

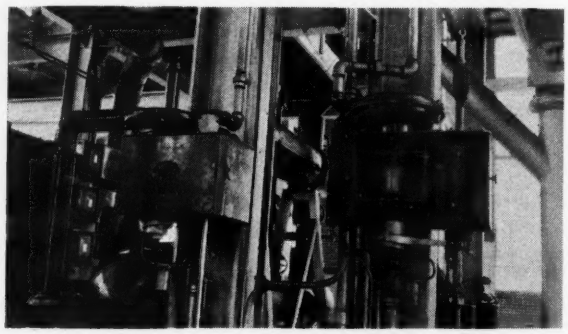


Fig. 10. Combustion controls for forced draft, induced draft and damper position

against the pressure of a spring. In so doing the pilot valve stem is moved, through appropriate levers, which uncovers ports to either end of a power cylinder. This moves a piston in the power cylinder to whose rod is attached connections to the damper or fan louvres, as the case may be, to regulate the draft. The power piston follows the amplifier in step until they become balanced. Then the regulator remains stationary until another change in conditions moves the amplifier.

The CO_2 recorders on the multi-point indicator and on the strip-chart are operated electrically by connections to a small motor on the Orsat apparatus shown in Fig. 3.

(To be continued.)

INDUSTRY, working hand in hand with science, has developed a mechanical device for detecting explosive or poisonous gases in enclosed places. Of particular use in excavations, ships' holds, submarines, and mines, these gas indicators have an uncannily keen "nose" for toxic gases, the presence of which is immediately indicated on an accurate gage.

Diesel Engine Exhaust Gases

Analysis and tests prove Diesel exhaust gases much safer than gasoline engine exhaust under comparable conditions and research on engine design has eliminated objectionable odors.

By H. L. KNUDSEN

Chief Engineer
Cummins Engine Co.
Columbus, Ind.

EXHAUST from a Diesel engine, from a physiological standpoint, has always been far safer than that of the gasoline engine, due to the extremely low carbon monoxide content. The same thing is true about the aldehyde, responsible, it is believed, for the odor and the smarting and stinging effect in one's eyes when the engine exhausted in a closed garage. This stinging effect may be associated also with sulphur dioxide, but the sulphur dioxide can always be kept low by using a fuel with a low sulphur content.

To get a clearer picture of the component elements of the exhaust gas and their relative quantities, the Cummins Engine Co. undertook an extensive chemical test of the exhaust gases. The principal compounds or elements in the Diesel exhaust are as follows: Carbon dioxide; free oxygen; free nitrogen; water vapor; carbon monoxide; acrylic aldehyde; sulphur dioxide. The first four of these are present in relatively large quantities and are physiologically safe. The last three named elements are present only in minute quantities in the exhaust of the Diesel engine. Two of them, acrylic aldehyde and sulphur dioxide, if present even in small quantities, are easily detected by their characteristic odors and are never present in quantities large enough to be dangerous physiologically, although they may be obnoxious if present in large enough quantities to be detected by their odors.

Carbon monoxide, on the other hand, is a colorless and odorless gas, extremely poisonous or toxic. When carbon monoxide is present in the air to the extent of 0.04 per cent or four parts in ten thousand, an exposure for 2 to 3 hr. causes headache and discomfort. With moderate exercise, 0.12 per cent will produce slight palpitation of the heart within 30 min. and a tendency to stagger in 1 to 1½ hr., with confusion of the mind, headache, and nausea developing in 2 hr.

A concentration of 0.2 to 0.25 per cent will produce unconsciousness in about 30 min. It will be seen, therefore, how essential for safety it is to reduce carbon monoxide in exhaust gases or to eliminate it completely. Tests made by the Bureau of Mines show that, depending on the air-fuel ratio in a gasoline engine, the carbon monoxide content in the exhaust gas varies from 1½ to 13 per cent the average being 6 to 7 per cent. The relationship of carbon dioxide to carbon monoxide in the exhaust of a gasoline engine for different air-fuel ratios as based on figures furnished by the Bureau of Mines is shown in Fig. 1.

Frederick C. Atkinson, Inc., of Indianapolis, Indiana, Chemical Engineers, Technologists and experts in gas analysis, made the exhaust gas analysis on a Cummins Diesel engine and found that within the rated operating range of the engine, carbon monoxide was present only in so minute quantities that it could not be detected by the Orsat method. For this reason a check test was made with the more accurate iodine pentoxide method, which is capable of detecting carbon monoxide in very small quantities.

Within the normal operating range of the Diesel engine tested, the carbon monoxide, which was based on iodine liberation, did not exceed 0.03 per cent. In studying the test results of carbon monoxide concentration in the exhaust gas as related to the surplus oxygen in same, a picture as represented by Fig. 2 is obtained. This is most interesting for it shows that with even as small an oxygen surplus as one per cent, which represents about a 30 per cent over-load, the carbon monoxide is still below the best result that can be obtained with a gasoline engine.

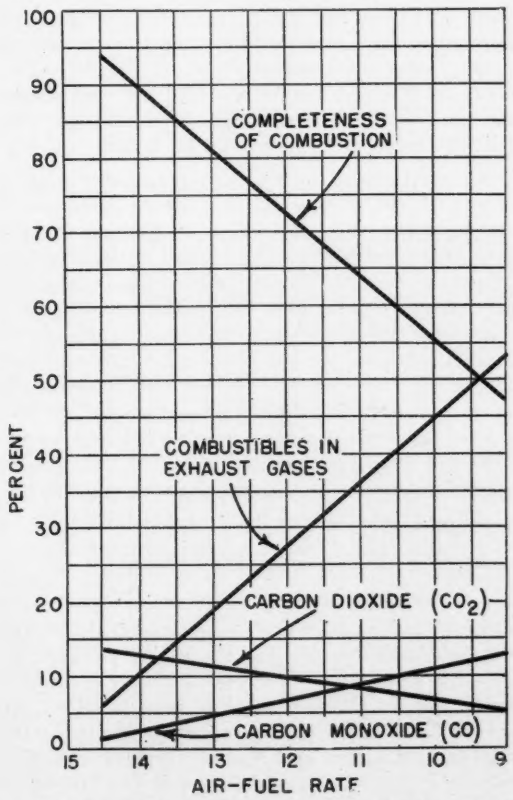


Fig. 1. Gasoline engine performance as a function of the air-fuel ratio. Data based on Bureau of Mines Report of Investigations No. 2487

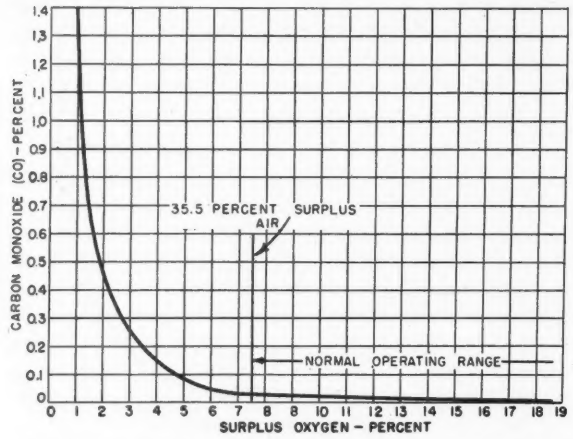


Fig. 2. Carbon monoxide in a Cummins engine exhaust as a function of the surplus oxygen

It is indeed interesting to compare the gas engine principle of combustion with that of the Diesel engine. At the optimum air-fuel ratio of about 14½ in a gasoline engine, 1½ per cent of carbon monoxide is produced. One would expect, as the air-fuel ratio increased, that a continued improvement would be shown; however, when less than 15 lb. of air per pound of gasoline is present incomplete combustion products such as carbon monoxide (CO), hydrogen (H_2), and methane (CH_4) are formed. This is not true with a Diesel engine and the higher the air-fuel ratio, the better the combustion. No methane, ethane, or free hydrogen has been detected within the operating range of the engine. Even at 120 per cent load, these elements were not found until an overload of 30 per cent is reached. At this point there is only 1 per cent surplus oxygen and methane to the extent of 1.53 per cent. Still no hydrogen or ethane could be found.

Determinations of acrylic aldehyde were most erratic and therefore one is disposed to question the accuracy of the test. At idling a determination of 0.006 per cent was made. The highest indication made was 0.045 per cent. However, most of the tests showed about 0.02 per cent. The determinations seemed to bear no relationship to load, speed or oxygen surplus and for this reason it is doubted that they represent actual values. The one thing that can be said with certainty, however, is that the characteristic aldehyde odor is absent and therefore, whatever actual amount was present, it was in a quantity so small that it was of no consequence.

Sulphur dioxide (SO_2) gas is not poisonous at low concentrations, but is strongly irritating to the eyes and membranes of the throat so that there is ample warning when this gas is present even in very small quantities. 0.05 per cent of sulphur dioxide, according to the Bureau of Mines, is actually pungent and produces a sense of suffocation: 0.02 per cent is intolerable, but not dangerous. The amount of sulphur dioxide in the exhaust gas depends upon the percentage of sulphur in the fuel and also on the load. Based on calculations, ½ per cent of sulphur in the fuel would produce on a volume basis about 0.02 per cent at full load and about 0.0165 per cent at no load or idling.

In Fig. 3 is shown the percentage of carbon dioxide and oxygen in the exhaust by volume at different speeds and loads between 400 and 1800 r.p.m. which is the speed range of the engine. Curves are shown for the following loads: 25 per cent, 50, 75, 100 and 120 per cent. No curve is plotted for 130 per cent since only one determination at 1800 r.p.m. at this load was made, the reason being that the exhaust at that point becomes smoky, there being ouly 1 per cent of surplus oxygen. The reason for the smoke, of course, is obvious. In a properly rated Diesel engine there should always be a considerable surplus of air or oxygen. In the engine investigated here, the surplus air at rated load and maximum speed is 35½ per cent or about 7½ per cent oxygen, which insures complete combustion and freedom from carbon monoxide.

It is interesting to examine the oxygen and carbon dioxide curves shown in Fig. 3. It will be noticed that for the same percentage of load based on the same mean effective pressure throughout the speed range, the oxygen surplus decreases as the speed increases, reflecting the fact that frictional horsepower increases not directly with the speed, but in some higher ratio, and therefore requires additional oxygen to produce the same brake mean effective pressure, and it also would indicate a drop in volumetric efficiency, caused by both actual throttling as well as by the greater degree of heating of the intake air at the higher loads.

Looking at the curves for carbon dioxide, we find an increase of carbon dioxide with an increase in speed. This again reflects an increase in frictional horsepower as the speed goes up, but since the carbon dioxide really is an indication only as to the amount of fuel burned there can be no reflection of the volumetric efficiency of the engine in these curves.

Water vapor present in the exhaust gas ordinarily is of little importance. In a fuel oil containing 15 per cent hydrogen, the water produced amounts to about 1⅓ lb. per lb. for fuel burned.

In conclusion, it should be pointed out also that the Diesel engine, because of the absence of any combustibles in its exhaust in addition to the practically zero carbon monoxide content, is particularly suitable for mine operation and indeed has been used for years in European mines for these very reasons.

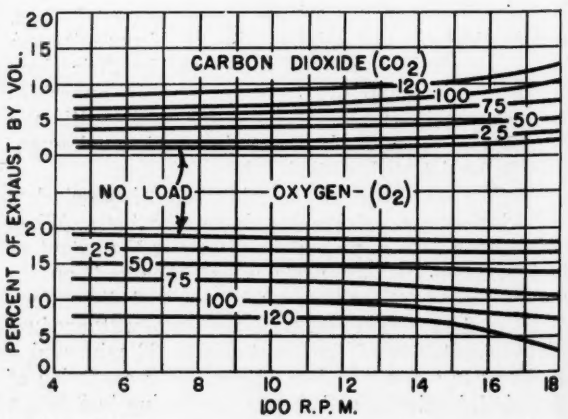


Fig. 3. Carbon dioxide and oxygen in a Diesel engine exhaust in relation to speed and load

3375 hp. in Office Building Diesels

RECENTLY the new Alfred I. duPont Building, a 17-story structure including stores, banking rooms and offices and an adjacent 400-car garage was opened in Miami, Florida. The new building is completely air-ditioned and the entire electric power and lighting load is carried by a Diesel power plant located in a soundproof room on the ground level.

Three main engines are installed. Each consists of a 16-cylinder General Motor, 8½ by 10 in., 2-cycle Diesel rated at 1050 hp. at 600 r.p.m., and driving a General Electric 700 kw., 208/120 v., 3 ph., 60 cycle, 4 wire generator. A smaller 8 cylinder, 5½ by 7 in. General Motors 4 cycle Diesel, rated at 225 hp. at 1200 r.p.m., is installed to carry the night and Sunday load. This engine drives a 150 kw. G. E. generator. All four engines are electrically started by Delco Remy electric starters supplied with power by eight Exide batteries, which also serve as emergency lighting supply in case of power failure.

Engine cooling water is supplied from a closed-type system and incorporates three Harrison Radiator Heat Exchangers on each engine; one cools the lubricating oil; the second handles domestic water and the third the engine water. The first and third are supplied with water from a Foster Wheeler cooling tower and the second with city water which passes through the heat exchanger to the domestic hot water heater for the building. It is estimated that the heat recovered from the jacket water will average 1,000,000 B.t.u. per hr. The cooling tower is located on the third floor of the garage and serves both the engine heat exchangers and the Carrier air conditioning equipment.

Exhaust gases from each engine passes through a Burgess snubber and from there to a common manifold leading to the brick stack extending the entire height of the building. Air entering the engine room is filtered both before and after the American Blower fan located on the balcony. Each engine is equipped with intake air silencers, visible in the photograph. No air is recirculated in the engine room, air not utilized for combustion is exhausted by means of an exhaust fan located in the rear of the engine room.

The G. E. switchboard extends the full length of the engine room and uses a "U" type bus construction made necessary by the heavy current carried. The switchboard has a complete complement of electrical instruments and in addition a Brown Pyrometer serving all 56 cylinders.

Sound-proofing is by means of a 2½-in. blanket of sound-proofing material attached to the walls and ceiling, over which is laid perforated Johns-Manville Transite blocks. A 6 in. I-beam located over each group of cylinders for a chain fall or block and tackle to facilitate repair and maintenance.

Engine foundations proper consist of a 2½ ft. slab resting on the floor. The engines themselves are supported from this slab by means of Hussman Spring Mountings. Each main unit weighs only 45 tons, including the generator, and it is interesting to note that these engines were assembled at the factory in Cleveland, tested and loaded on freight cars, shipped to Miami, unloaded and skidded onto the foundations without being disassembled.

Fuel oil storage consists of two 3000-gal. tanks buried in an areaway. A Viking transfer pump takes the fuel from the main storage tanks to the day tank for each engine. There is also a 500 gal. lube oil storage tank from which another Viking transfer pump serves a lube oil day tank for each engine. The oil passes through two Purolator filters on its way to the engine and is transferred from the engine back to the tank through a Gould's Hydroil.

Piping for all engines is installed on the unit system, each engine having its own piping for water, fuel and lube oil supply and return. Piping, all with Crane valves and fittings, is carried in trenches with a grating for complete accessibility.

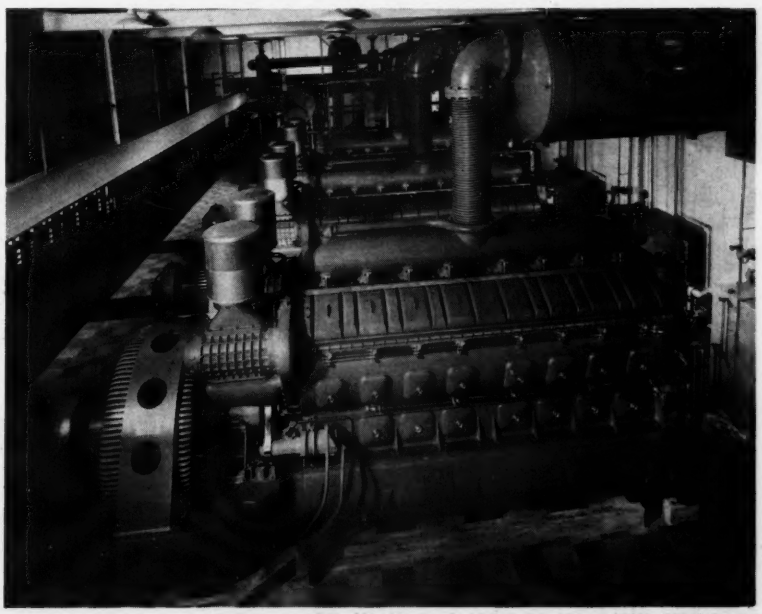
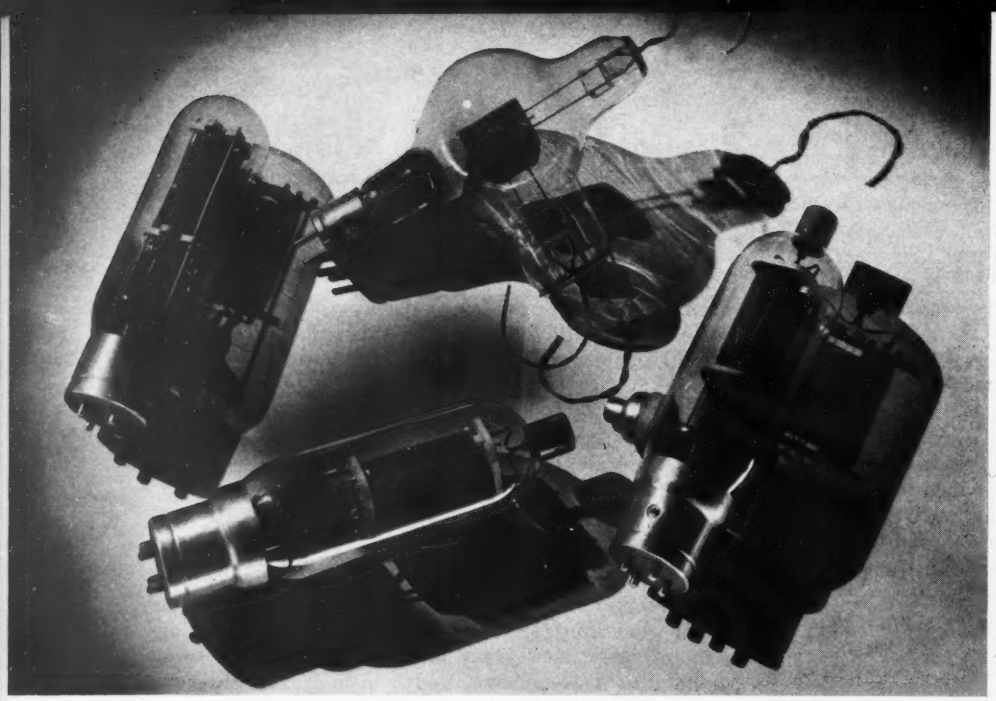


Fig. 1. General view of the engine room in the new Alfred I. duPont Building in Miami. The power plant consists of three General Motors engines rated at 1050 hp., 600 r.p.m. and one 225 hp., 1200 r.p.m. engine for Sunday and night loads. The small engine is at the far end of the room, almost completely hid by the larger engine

Photo, Diesel Progress



Photo, Courtesy General Electric Co.

Electron

Part XXXVII

By

A. W. KRAMER

IN PRESENTING this concluding article in this series, we are going to consider some of the non-technical factors involved in the application of electron tubes in the power industry. It would be more correct, perhaps, if we said the non-application of electron tubes in the power industry because it is a fact that the power industry has been very reluctant to use tubes. Whereas tubes will be found performing an endless variety of functions in industrial plants and factories of all types, the average power plant, large or small, makes little or no use of them. As one public utility engineer pointed out recently, while one can go into restaurants and department stores and see doors opened mysteriously and silently by photoelectric cells, one would have to travel long and diligently to find comparable installations in the show rooms and electric shops of the big public utility companies.

There are, no doubt, reasons for this. One of these reasons, probably, lies in the abundant knowledge of electricity possessed by the power engineer. He is too well versed in the science of electricity not to realize that despite the strange powers of the electron tube, it is not a panacea for the solution of all his problems. It is easier to "sell" a non-electrical person on the wonders of the electron tube than the orthodox electrical engineer who knows as much as the salesman. While the opening of a door by the interception of a light ray may be very wonderful and impressive to the restaurant owner who sees in it a chance to attract trade, to the engineer of a public utility company the "stunt" is simple and he is little impressed. Yet, the chances are that if he could subordinate his personal reaction and consider the effect upon the general public, he also might find in it an opportunity to build prestige and geed will for his organization.

On the other hand, if the utility engineer's considerable knowledge of electricity tends to limit his use of the simple applications of the electron tube, his lack of specific knowledge of electronics at the same time leads him to avoid its more complex applications—those in which electron tubes might prove most useful. Conditioned by experience and education to equipment of rugged and massive proportion, the power engineer's first reaction to the apparently fragile glass tubes first offered for his use is one of distrust. Such fragile affairs have no place in his world. Coupled with this attitude regarding tube construction is his lack of knowledge of electronic technique. Here is a field with not only a new set of terms and parameters, but involving magnitudes of frequency, capacity, resistance, impedance, utterly beyond those he previously has dealt with. Whereas the communication engineer, in whose hands tubes first developed, takes to them like ducks to water, the power engineer tends to avoid them. With a large number of men in the electrical industry holding responsible engineering positions who are not thoroughly grounded in electronic theory and fundamentals, it is inevitable that the use of tubes should be retarded. Indeed, it has been stated that electronics will not take a foothold in the utility industry until the present generation of executive engineers passes on.[1]

To this state of affairs there are, as in all things, a number of exceptions. There are one or two utility systems which, because of the progressiveness of their chief engineering executives, have made wide use of electronic devices. Chief among these is the American Gas & Electric Co., which under the forceful direction of Philip Sporn has made numerous applications of electron tubes in all parts of its far flung system, not only for control and communication, but in heavy power work. It is on this system that the first thyratron motor went into operation and in whose stations electron tube exciters were first used. On this system also, one cycle carrier-current relaying was first inaugurated.

Another utility system which has made wide use of electron tubes is the Tennessee Electric Power Co.

[1]Electrical World, p. 43, July 20, 1935.

Tubes—Principles and Applications

So we come to the end of our story. With a final consideration of some of the human factors involved in the use of tubes the series is brought to a close. As indicated, these human factors have retarded the use of tubes in the power industry and if, by stimulating interest in the subject, the articles have contributed anything to remove some of these obstacles, they will have served their purpose.

Under the direction of E. E. George, electron tubes have been applied on that system for all sorts of protective and test purposes. Strangely enough, the use of electron tubes on that system has been confined almost entirely to tubes of the high vacuum type—no gaseous discharge tubes being used anywhere.

One of the most interesting features of the use of tubes on the Tennessee system is Mr. George's use of tubes in parallel. As pointed out in the earlier chapters of this series, the current output of high vacuum tubes is very small, at best capable of actuating only the most delicate relays. In order to get enough power to operate ordinary relays it becomes necessary to use two or more tubes in parallel so that their outputs may be added.

Without certain precautions, however, it is practically impossible to operate even a single stage amplifier with tubes in parallel even if push-pull is used and stability is improved by feedback. Tubes in parallel tend to oscillate at undesired frequencies, resulting in reduced output, shortened tube life, destruction of insulation by corona and other difficulties. These undesired oscillations are called parasitic oscillations.

Such parasitic oscillations with tubes in parallel can be prevented, by introducing resistors in the grid and screen circuits, locating these as close to the tube terminals as possible. There is nothing particularly new in this suppression of parasitic oscillations by means of resistors, the scheme having been used for many years in radio transmitter circuits. The novelty of Mr. George's use of tubes in parallel lies in the multiplicity of tubes used. Instead of operating two or three tubes in parallel as in the case of some of the older radio transmitter circuits, Mr. George uses 10 or 20 tubes in parallel. With push-pull circuits, he employs 10 tubes in parallel on each side of the circuit. A circuit of this type is shown in Fig. 1 which happens to be the vacuum tube type bushing device used by the Tennessee Electric Power Co.

As applied in this circuit, very satisfactory results are obtained with 1000 ohm resistors in the grid circuits and 100 ohm resistors in the screen circuits.

The bushing amplifier is an interesting example of the sort of application that can be made of electron tubes if one has some knowledge of their capabilities and the technique of developing circuits. It takes the place of potential transformers. A capacitance tap on a high voltage bushing acts like a constant current generator supplying about 5 mils at 60 cycles with any load up to that using a substantial portion of the available 3000 to 5000 v. The input transformer on the amplifier uses less than 100 v. and is shunted by an adjustable resistance for calibrating and an adjustable condenser for matching phase angle. Since the reactance of the input transformer is high, excessive voltages are likely to develop during transient conditions and a protector tube is shunted across the input. The circuit is provided with feedback through the condensers C. Without feedback the regulation of the device would be inferior to manufacturers' standard potential devices and the stability would be very poor. The use of feedback permits improved regulation and practically eliminates transient disturbances in the output.

Oscillographic records during staged short circuit tests on a 110 kv. system show that the output of the bushing amplifiers is a duplicate of that provided by high tension potential transformers, except for changes in ratio with loading and except for the unknown errors in the capacitance device caused by temperature, leakage, etc.

The cost of building this bushing amplifier is comparatively low. As shown by the accompanying bill of materials, the total cost of the component parts adds up to less than $150.00.

This bushing amplifier is entirely reliable and at the present time the Tennessee Electric Power Co. has seven of them in service.

One of the factors in electronic work about which power engineers usually express concern is the prob-

Bill of Material for Bushing Amplifier

Item No.	Quan.	Net Cost Each	Manufacturer	Description
1	1	$22.00	Superior Swbd. Device Co.	Weatherproof inst. transf. cabinet — #IT24204
2	1	24.50	Westinghouse Elec. & Mfg. Co.	18″ × 23″ × ¼″ Micarta — #431
3	22	.12	H. H. Eby, Inc.	#8–E Sockets
4	20*	1.25	RCA Mfg. Co.	25 L 6 Tubes
5	2**	1.00	RCA Mfg. Co.	OA–4–G Tubes
6	2	5.00	United Transf. Co.	#31011 Input Transformers
7	2	8.00	United Transf. Co.	#29487 Output Transformers
8	4	2.25	Western Electric Co.	#138 Q A Condensers
9	1	4.50	Western Electric Co.	#187 A Condenser
10	1	.79	Western Electric Co.	#142 B Condenser
11	20	.45	International Resistance Co.	Type WW 4 — 1000 ohm resistors — 1%
12	4	.81	International Resistance Co.	Type WW 4 — 40,000 ohm resistors — 1%
13	2	.55	International Resistance Co.	Type WW 4 — 15,000 ohm resistors — 1%
14	2	.28	International Resistance Co.	Type MW 4 — 15 ohm resistors — 5%
15	20	.28	International Resistance Co.	Type MW 4 — 100 ohm resistors — 1%
16	1	3.00	Ward-Leonard, Inc.	507–77 Rheostat — 10,000 ohms
17	1	3.00	Ward-Leonard, Inc.	507–75 Rheostat — 1,000 ohms
18	1	.21	Burstein-Applebee Co.	Johnson #66 Stand-off Insulators
19	1	.05	Mueller Elec. Co.	# 27 Clip
20	1	.03	Mueller Elec. Co.	# 29 Clip Insulator
21	1	.40	G. E. Co.	30 A–250 V.–2 pole Cartridge Fuse Block
22	1	1.26	Penn Union Elec. Corp.	8 Point Swbd. Terminal Blocks
23	1	.21	Wholesale Radio Serv. Co.	#YM 13257 Shield Can

* Add desired number of spare tubes — 5 recommended
** Add desired number of spare tubes — 2 recommended
G. E. lead-in cables should be the same as furnished on our order 50456.
Westinghouse lead-in cables should be the same as furnished on our order 46714.
OA 4–G tubes are on development test to replace Westinghouse KX–642 protector tubes.
All WW 4 resistors to have lug terminals.

able short life of electron tubes in continuous 24 hr. service. The experience of the telephone industry and the air line companies who rate tubes on a conservative basis shows that tube life for continuous duty can be measured in years rather than months, assuming proper circuit design. Indeed, it has been pointed out that where tubes are used a considerable portion of the 24 hr. in a day, it may be better practice to keep the filaments hot continuously than to switch them on and off. By operating tubes intermittently the periodic strains produced by the repeated heating and cooling of the tube elements tend to shorten the tube life to a greater extent than the mere deterioration of the filament under the action of continuous heat.

Tube Life

The life of tubes can be enormously extended by operating them at small reductions in heater voltage and somewhat larger reductions in plate voltage. The necessary changes in circuit design to accomplish this are simple. An additional stage of amplification may be necessary, but tubes are inexpensive and such an additional stage may be provided at small additional cost.

In ordinary practice when operating tubes at rated output, the life of standard receiving tubes is around 2000 hr. Circuits designed for lower output will increase the average life to more than 10,000 hr. Telephone engineers stated recently that they could make tubes with a life of several years if this is found desirable for non-attended repeater stations. Such unattended repeater stations are in actual use on some of the newer telephone circuits and in some remote regions of the country where electric power is not available, the power for these repeater stations is supplied by storage batteries charged by windmill generators.

The average life of tubes operated at rated heater and plate voltage and in continuous service seems to be between a year and six months. On the Tennessee Electric Power system, experience indicates that tubes which stand up for the first few days do not require much attention in the way of test or inspection for 3 to 6 months. When worked with heater voltages 10 per cent below normal and with screen voltages reduced 25 per cent or 50 per cent and the plate current normally very small, the life of such tubes is measured in years.

The apprehension many power engineers have displayed regarding the fragility of tubes is unfounded. Tubes, whether made of glass or entirely of metal, are quite as rugged as other electrical apparatus, certainly they are much more rugged than most mechanical relays and instruments. Metal tubes are not necessarily more rugged than glass tubes—either type is liable to damage if dropped. Metal tubes offer more complete shielding and perhaps somewhat better heat dissipation but aside from these features the advantage of metal tubes, insofar as the user is concerned, is largely psychological. Glass tubes have gone through airplane crashes and come out unscathed, a fact which attests more probably to the skill used in mounting them than to the ruggedness of the tubes themselves, but it shows that tubes can be made to withstand severe service. Vibration need be no deterrent to the use of tubes; they are used in automobiles and train service under the most severe conditions with no ill effects.

Disposing of the power engineer's concern about tube life and fragility, there remains the question of

knowledge. With notable exceptions the electronic field is a young man's field; it belongs to the younger engineers who, during the past 15 years, have grown up with the industry, those who have been conditioned from the beginning to such things as plate impedance, grid swing, transconductance and all the other terms used in the field of electronics.

These younger men, as a consequence of their familiarity with tubes in their engineering courses in college, are well qualified to undertake the tube development work for utility companies.

Here again the experience of E. E. George may be cited. His experience indicates that a team of two men is a useful combination for most development work. The man who has considerable ingenuity along with good judgment in developing work may not be a skilled or neat wireman and cannot assemble, build and test equipment for permanent use even if he is good on laboratory setups. Two men working together will usually coordinate their work so that each man does the work he can do best. If one of them is familiar with telephone switchboard wiring and is a good all around mechanic, it is possible to build equipment which is constructed well mechanically and which has sufficiently good appearance for permanent use on power systems. Of course, larger companies with several developments under way at once may find use for a group of engineers on electronic work.

These suggestions regarding organization for electronic work raise the question: If as is stated here, electronics is a young man's field and that men trained in the electronic art are best fitted to do the work, why, by means of a series of articles such as this, endeavor to interest non-electronic engineers in the art?

There are several aspects to the answer to this question. First, because electronics is a young man's game is no reason for assuming that those who were not educated along electronic lines in their earlier years cannot acquire a good working knowledge of the field. In its deeper phases, electronics can be extremely complex, but as was stated in the first article of this series, reduced to its fundamentals the electron tube is a very simple device and its operation can readily be grasped by an intelligent child of 12 if properly explained.

The aim in these articles has been not so much to make every reader an expert in electronics as to make him conscious of the power of the electron tube and to point out how it might prove useful. The development of electronic devices and their application demands a certain amount of enthusiasm on the part of those who are in a position to authorize such development work and one of the purposes of these articles has been to stimulate such enthusiasm. In a large public service company, for example, unless the executive engineers are "sold" on the application of electronics there is little likelihood of their creating an electronic development program. The fact that the two companies mentioned in this article have accomplished so much in this field is due largely to the enthusiasm and belief in electronics by a few individuals in high places.

The use of electron tubes in the power industry has not been scratched. Except for an occasional photoelectric smoke indicator one may visit dozens of plants, small and large, without a single tube installed. Yet, as we have endeavored to show, numerous uses of tubes are possible in plants even today. In the heavy power field, 25,000 kv-a. hydrogen-cooled synchronous condensers are operating today with excitation systems having neither brushes nor moving parts. These machines use ignitron rectifiers together with electronic voltage regulators. In addition to freedom from moving parts, these machines have higher speed response, a speed response in fact that is virtually instantaneous.

For control purposes opportunities for the use of electron tubes in power plants and on power systems are numerous. For relaying, telemetering, communi-

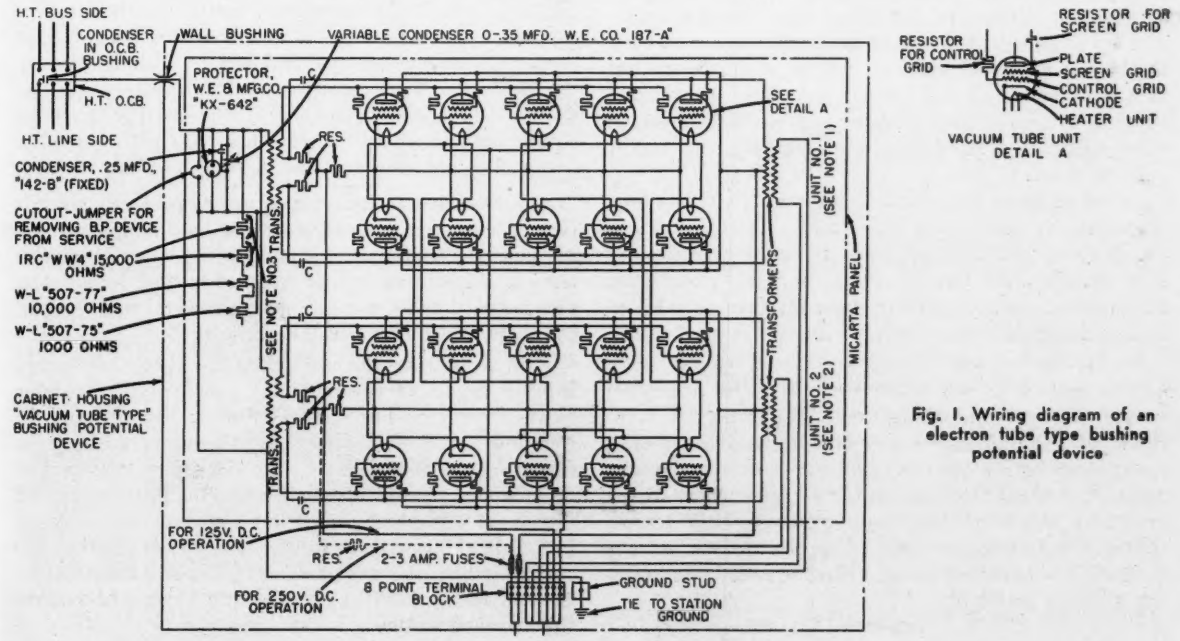


Fig. 1. Wiring diagram of an electron tube type bushing potential device

cation, protection and measurement their increased use is inevitable. In E. E. George's bushing amplifier we have seen how easily tubes displace potential transformers; unquestionably, many other opportunties for similar uses exist. In the boiler room the entire field of combustion control is fertile for the use of tubes. In furnace operation they offer potential protection against flame failure and consequent furnace gas explosions. A recent installation of tubes for this purpose in a Cedar Rapids, Iowa, plant on a pulverized coal furnace was put to every possible test that could be devised and it functioned 100 per cent. As smoke indicators they offer much more than mere smoke indication, for here, too, the action can be coordinated with combustion control. In water treatment work tubes have been used to control chemical treatment. Carrier current control has already been applied extensively to transmission line operation, but future development may see this form of control introduced within a station itself.

As a means of intercommunication between the main control room of a power station and the various boiler and turbine room stations electron tube apparatus is already displacing older systems. At the new Quindaro station of the Kansas City, Kansas Municipal System, the public address system between the main control room and the boiler and turbine room represents an investment of almost $8,000. Here the more conventional Selsyn system is a secondary means of communication.

For communication between the various stations of a large system, as pointed out above, "carrier" is in active use, but in recent years many power systems have obtained licenses to operate radio stations not only as a means of communication between power stations, but between the fixed stations and mobile maintenance crews.

In the field of motor control we have already indicated how the grid controlled rectifier may be the final answer to the long search for a variable speed a.c. motor. Similarly for the long distance transmission of energy, tubes may once more bring us back to the use of direct current, not as a substitute but as a supplement to our present far flung alternating current systems. For elevator service, the electron tube rectifier even today is displacing the motor generator set.

Most of these are developments well within range of possibility today, but there may be possibilities in the electron tube for the power industry of which we now have not the faintest suspicion. The production of electrical energy directly from the heat in the fuel is something that has been talked and dreamed about. Who knows but that the electron tube in some unknown form may not ultimately solve this problem?

And so we come to the end of our story. If at times we have appeared unduly enthusiastic we offer no apology nor make no excuses. To anybody who has talked across the oceans to the far corners of the world by means of these mysterious glowing devices nothing is impossible and we prefer to err on the optimistic side rather than to run the risk of discounting a single possibility.

THE END

Ignitron Rectifier of 3000-Kw. Rating Previewed

BEFORE DELIVERY to the New York Central Railroad, the largest Ignitron rectifier ever built by Westinghouse was demonstrated before officials of railroads, chemical plants, and other heavy industries Tuesday, May 2, at East Pittsburgh, Pa. The rectifier, rated at 3000 kw. and 640 v., and consisting of two six-phase sections, will be installed about June 1 at a new substation nearing completion at 126th Street and Park Avenue in New York City for New York Central trains operating out of Grand Central stations.

Convincing evidence of the trust the Ignitron rectifier has earned for its reliability is this installation to handle one of the greatest concentrations of railroad traffic in the world, made even larger than usual through World's Fair impetus. Although costing 10 to 15 per cent more than a rotary converter of similar capacity, its efficiency, smaller bulk, and completely quiet operation makes it more acceptable, especially as it is to be located in a residential district.

The apparatus is designed to operate at 4688 amp. full load, 7031 amp. for two hours and 14,063 amp. for one minute. The load at this station is beyond the capacity of any contemplated installation, so that the unit is equipped with a current-limiting regulator that will come into play when the load demand exceeds the overload rating of the rectifier. One of the new Silverstat regulators is being used for this purpose. It will operate to control the grid of the Thyratron control tubes. The Ignitrons use the new cooling system that is corrosion resisting and that does not require a heat exchanger.

The station is fully automatic and is controlled by Visicode supervisory-control equipment. Over this supervisory circuit the operator at Grand Central Station can start or stop the unit, control five track-feeder breakers (one emergency), and receive an indication of the existence of potential on the high-voltage bus, as well as check the operation of the battery-charging equipment and whether anyone has unlocked the station doors. Telemetering over direct wires also is provided.

AN absorbed oil film, which resists perfectly the action of a solvent, is easily removed by a simple polishing process. If the steel surface is rubbed with a mixture of chromic oxide and water, followed by a treatment with the dry powder, no trace of oil will remain, as can be proved by a water wetting test.

But then comes the real difficulty—that of removing the last traces of the polishing powder. Use rubber gloves, made perfectly free from oil by dipping in cleaning solution followed by thorough washing in water. Hold the object to be cleaned in the gloved fingers of one hand and vigorously rub with the gloved fingers of the other, under hot running water. After a final flushing with distilled water to ensure that the surface when dry does not carry traces of salts from the tap water wash in hot absolute alcohol to remove the attached water.

Packaged Steam

Laundry Plant solves steam problem by installing factory-assembled tubular boiler.

By C. C. HARRINGTON

THE MANAGEMENT of the Dydee Wash Co., in Roxboro, Pennsylvania, has successfully solved its boiler house problem by installing a factory-assembled boiler with a built-in oil burner. The only preparation that the company had to make to receive this unit was the construction of several low concrete footings to match the base of the boiler. No masonry walls or partitions were required after the boiler was received. The company merely connected up the various pipe lines, ran a vent pipe through the roof, and the boiler was ready to operate.

This boiler is a 70-hp., marine-type unit. It came mounted on a structural steel base that fitted on the concrete footing provided by the laundry. In outward appearance the boiler proper is enclosed in a large, horizontal drum, with a small, separating drum on top. The burner is built in the front of the main drum, and combustion gases are removed by a vent pipe at one side of the front.

This fire-tube boiler works on a 4-stage, down draft principle, the oil burner being augmented by a blower. The hot gases leaving the burner are blown through the center of the drum to a refractory chamber in the rear. At this point the gases are divided and return toward the front through sets of tubes on either side of the center passage. The gases then move through a lower set of tubes toward an unlined chamber in the rear. The final passage is through the lowest set of tubes, from which the gases are removed by a vent at one side of the front. Operating at a steam pressure of 80 lb., the flue gases are able to be vented at less than 400 deg. F.

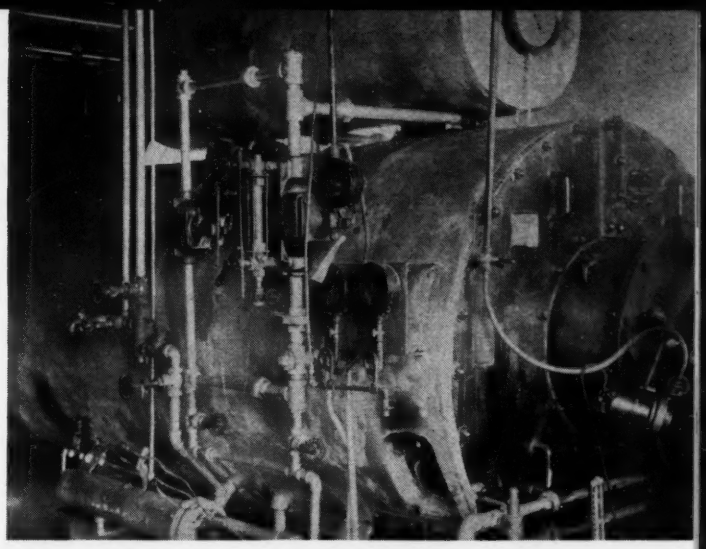


Fig. 1. Oil fired, factory-assembled boiler in plant of the Dydee Wash. Water level and flame control switches are shown mounted on the side

The pressure-type oil burner operates on a high-low flame cycle. When the steam pressure reaches 80 lb. the burner automatically drops to the low flame condition. As soon as the pressure drops 2 lb., the high flame starts up until the pressure reaches normal. A motor-driven blower is provided to give adequate draft for the burner, which is automatically regulated to give the proper mixture of oil and air for the complete combustion. Bunker-C fuel is heated by an electric heater for starting, after being pumped from a 2000 gal. storage tank. Steam heaters replace the electric heaters as soon as adequate boiler pressure is generated.

An insulated separating drum on the top of the boiler assures that dry steam will be delivered to the steam line under all load conditions.

Being a completely factory-assembled job, the boiler was tested at the manufacturer's plant, and the test data given to the management of the Dydee Wash. These tests verified the manufacturer's guarantee of better than 80 per cent efficiency for all loads from 30 per cent up to full rating.

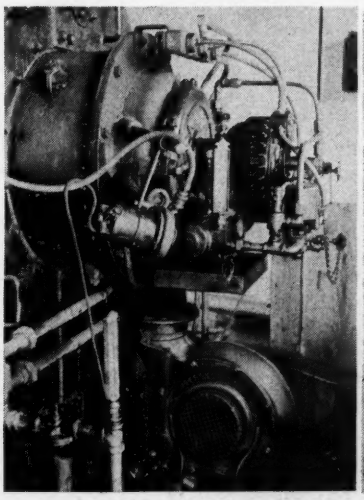


Fig. 2. Oil burner and blower at the boiler front

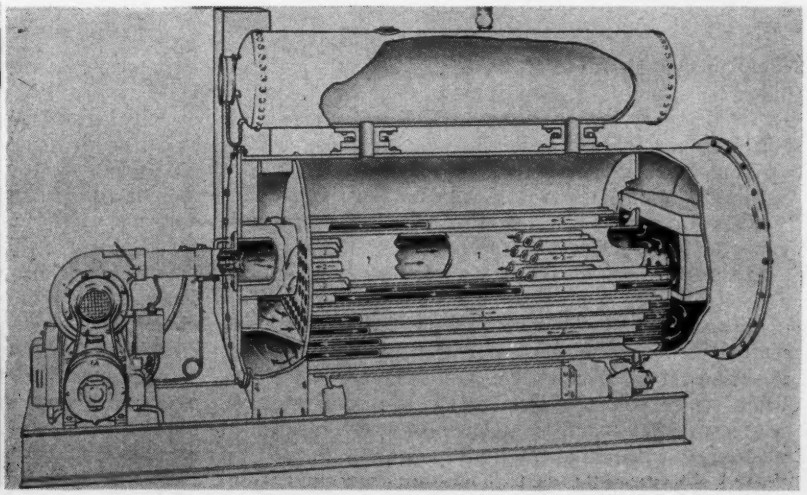


Fig. 3. Cut-out diagram of boiler unit showing four pass down draft gas travel

Water Conditioning Should Not Be Limited to the Boiler

By J. A. HOLMES

National Aluminate Corp.
Director of Service
Chicago, Ill.

WATER is one of the most commonly used tools of the engineer and chemist. Practically all industries use water either for domestic consumption, steam generation, plant processes, or air conditioning. It is indeed unfortunate that such a universally used product is never found naturally in a pure state and that it creates so many varying problems. Most engineers and chemists have had unusual problems dealing with plant and boiler feedwater, and this article deals with some of these problems.

Not so many years ago the average engineer was satisfied to keep his boiler reasonably free from scale so as to conserve fuel and to keep his equipment from completely plugging up. As ratings and temperatures increased it was found that every trace of scale formation had to be eliminated to prevent tube burnouts, especially at the evaporating surfaces. With this problem solved, in most cases, it was natural that the engineer should attempt to improve the condition of the non-evaporating surfaces such as economizers, rear passes of boilers, feedwater distributing system and all auxiliaries. Even with well operated external water softening equipment, scale or corrosion would occur without some direct treatment in the feedwater.

Boiler-feed is not always the only water problem that the power engineer has. If cooling water is used, especially in recirculating systems, or if water must be heated for domestic or plant use, then there are possibilities of scale, corrosion, and slime.

Through the Industrial Plant

Following the flow of water through an average industrial plant is a good way to visualize the difficulties that may be encountered. Well water may contain iron, manganese or high quantities of unstable calcium and magnesium carbonate that will be scale-forming in pipe lines even though no heat is applied. Surface water may contain mud, traces of suspended solids, or color that should be removed. Many plants install settling basins, filters, or softeners to condition the water before sending it on for plant consumption. If the water is to be thus treated, it is necessary to select equipment and chemicals for treatment suitable to the conditions of each individual plant. Frequently these conditions are such that clarification or softening equipment cannot be installed and consequently the water must be used in its natural state.

The water may pass through heat exchangers or similar apparatus to recover heat or to provide heat for high temperature plant water. This equipment must be protected from scale and corrosion. Next in line are usually open or deaerating heaters to reclaim low temperature exhaust steam and to drive off gases from the feedwater. Next are the feed pumps, closed heaters for reclaiming high temperature steam, economizers, and then the boilers. All of this equipment must be protected from scale and corrosion. In addition a separate cooling system may be used for condensers, coolers, Diesel engines, or other equipment.

Nature Contaminates—Not Purifies

To help understand the methods used for such protection one should remember that when water is formed in its pure state by condensation as rain or snow, from then on nature is trying to contaminate or put into water such substances as gases from the air, minerals from the earth, and organic material from vegetation or plant wastes. However, as soon as man starts to handle water most of the substances in the water begin to drop out to cause corrosion or scale. There are two ways to prevent this. One is to assist the removal of harmful substances to a minimum point in special equipment, and the other is to stabilize the water so that there is no reaction whatsoever. Thus either the harmful substances are reduced to a minimum or they are fixed so that the water leaves the system in the same form that it enters it.

Removal is accomplished by chemical treatment in softening or filtration equipment with which most engineers are familiar. Recent refinements are special coagulants, external phosphate removal of calcium, organic exchangers, improved design of lime-soda type softeners, and silica removal by supercoagulation. The principal problem encountered in external treatment is to get maximum removal of incrusting solids without undue cost or excess treatment. Softeners are used for the purpose of removing calcium and magnesium hardness and consequently every effort should be made to reduce these solids to a minimum. Even then the minute traces left may cause scale and require after-treatment to protect the feed and boiler system. The lower the residual hardness from a softener the easier it is to protect feedlines, pumps, valves, heaters, and economizers. For example, a water softened to 20 or 30 p.p.m. will be more than two or three times as incrusting to an economizer, as a water of 10 p.p.m. hardness because the higher the hardness, the less stable it is and the greater the tendency to form scale.

Stabilization of water is not a new idea in water treatment because ordinary tannins have been tried for

that purpose for many years. However, it is only recently that study has been given to the problem so that this method could be controlled and used at high temperatures. Stabilization of water has also been done by recarbonization and acidification in city plants but this has not been advisable in power plants. A combination of chemicals has been evolved which, used in small quantities (1 to 10 p.p.m.) causes no chemical reaction but (1) stabilizes all the incrusting solids at any temperature that may be encountered in a steam plant and (2) remains stable under the widely varying conditions of pH, alkalinity, etc., encountered in water.

Stabilized Water Use

The possible uses of stabilized water are many. Packing and distilling companies heat large quantities of water for plant use. Their heaters scale up rapidly but by stabilizing the water the heaters are kept clean. Long pipe lines carrying untreated or treated water are protected from scale with stabilized water. Economizers and high temperature heaters are sometimes difficult to keep clean even with softened water, but by using a specially prepared mixture of organic materials economizers are kept clean, and closed heaters that would scale within a week's time using water of ten p.p.m. (approximately 0.5 grain) hardness are kept operating over long periods at temperatures well in excess of 300 deg. F. These types of organic materials, properly selected, have been used in power plants with the temperatures encountered at 900 lb. boiler pressure. Also steam and ammonia condensers, engine jackets, or any other equipment using cooling water should be protected by stabilized water.

Table I. Showing the effect of water treatment, which does not affect the water for food products or domestic use, on the cleaning frequency of hot water heaters. Hardness and alkalinity are both expressed in grams per gallon

Plant	Total Hardness	Total Alkalinity	Frequency of Cleaning Before	After	Temperature
1.	19.0 g.p.g.	10.6 g.p.g.	15 da.	Not necessary	209 Deg. F.
2.	33.2	22.9	7 da.	12 months	200 Deg. F.
3.	19.6	19.0	14 da.	Not necessary	180 Deg. F.
4.	17.0	14.0	7 da.	Not necessary	150 Deg. F.
5.	10.7	14.4	6 wk.	Not necessary	150 Deg. F.
6.	28.9	21.5	2 wk.	Not necessary	175 Deg. F.

Many times a combination of complete removal and stabilization of hardness is used. For example the untreated water is first used through cooling equipment, or may be heated prior to softening. The water is stabilized to keep this equipment clean. After softening the water is again stabilized so that it will pass through all boiler feed equipment without scaling. In the boiler proper a phosphate type of treatment may then be used to again protect against the type of scale precipitated by evaporation and concentration.

To many engineers this may sound very complicated and some will point out that if water is properly treated at its source by zeolite or some other process no trouble will be encountered. Many times, however, it is not

Table II. Proper treatment is just as effective in high temperature heaters. Hardness and alkalinities are expressed in terms of grains per gallon

Plant	Total Hardness	Total Alkalinity	Frequency of Cleaning Before	After	Temperature
1.	7.5	6.5	7 da.	40 da.	275 Deg. F.
2.	0.5	2.8	30 da.	Not necessary	300 Deg. F.
3.	0.4	3.0	7 da.	120 da.	375 Deg. F.
4.	0.7	3.4	7 da.	Still clean after 2 mo.	330 Deg. F.
5.	0.1	3.5	6 wk.	Still clean after 6 mo.	300 Deg. F.

Table III. Operation of recirculating systems too are improved by water treatment. Hardness and alkalinity are expressed in grains per gallon

Plant	Total Hardness	Total Alkalinity	Frequency of Cleaning Before	After	Type Equipment
1.	1.7	13.1	Often	None	Diesel
2.	20.0	11.8	60 da.	None	Diesel
3.	20.4	16.0	6 mo.	None	Surface Condenser
4.	7.5	2.5	3 mo.	1 yr.	Surface Condenser
5.	21.4	14.8	4 wk.	None	Refinery Condenser
6.	23.0	10.0	6 mo.	None	Ammonia Condenser

economical to remove all incrusting solids at the source because all the original plant water may not eventually be used for boiler feed and therefore it is usually more economical to stabilize than to soften the general plant supply. Also the heat balance may be such that even the best of externally softened water still needs stabilization.

The question arises whether chemicals used for stabilization affect or hold up softening plant reactions. Unless an excessive amount is used lime-soda ash sludge adsorbs the stabilizing chemicals and in some cases this may actually improve coagulation. Certain types of organic materials used to stabilize the feedwater, also act as a coagulant in the boiler water to condition any sludge formed there.

Table I shows the protection of hot water heaters by a treatment that does not affect the water for use in food products or domestic consumption.

Table II shows the protection of high temperature closed heaters. Table III shows the stabilization of water in recirculating cooling systems and type of equipment protected.

Cities, especially those that do not have softening and recarbonation equipment, can stabilize water so that scale in household heaters, meters, and pipe lines is eliminated. The amount of chemicals required is low and cost negligible. Hotels and other large institutions benefit most by this protection to their equipment. Since the amount of chemicals used is so small per million gallons of water treated it would obviously be more economical for the city to apply the treatment rather than the individual users.

Before applying a stabilizing treatment, careful study should be made of the water to be used, deposits formed, temperatures, final consumption of the water, and proper point of application because, as with all water treatments, some control and supervision are required.

Extreme pressure lubricants such as are used for hypoid gears where the intensity of loading is very high, may with advantage be used for the pre-conditioning of bearing surfaces. This type of lubricant contains sulphur of chlorine which will react with the metal when the temperature, due to the heat of friction becomes high enough, forming a tough, resistant film. The very fact that high loads may be used with safety in the running-in operation means that in a comparatively short time high spots will be polished down, and the surface will acquire the extreme burnish so greatly desired since it spells both safety and lowered power loss. The extreme pressure oil is then replaced by an undoped lubricant of a viscosity suited to the load which is to be carried.—Claypoole before the A. S. M. E.

Welding As a Function of Superheater Construction*

In the design and construction of the Turner water-regulated superheater welding has made possible application of certain heat transfer principles.

By ROBERT C. FITZGERALD

IN DESIGNING the Turner superheater, the inventor arrived at the conclusion that some independent but controllable coolant must be introduced in the superheater to make its location in the furnace possible. The problem at once evolved into one of joining steam tubes and water tubes together in such a way that the unit would have mechanical strength to withstand the stresses of operation and at the same time provide ample heat transference from the steam tube to the water tube, so that the steam tube would have ample protection from the radiant heat of the fire when not actually superheating steam. Also, they should be so intimately joined that in the absence of either one of the heat absorbents, the other would absorb all the heat impinging on the unit.

Many methods of fabricating this kind of an assembly immediately present themselves, such as boring a thick walled tube longitudinally to allow steam passage, the center of the tube being used for cooling water. This and many other schemes could possibly achieve the desired results, but to be practical the design had to be simple and had to permit of inexpensive fabrication. Some sort of welded assembly was obviously the answer to the problem, so that method of fabrication was chosen.

The superheater is essentially a series of steam tubes, arranged longitudinally around a larger diameter central tube, and welded in such a way that about one-half the area of the steam tubes is in contact with a larger diameter water tube.

Figure 1, center, is a cross section of the superheater element that is exposed to the full radiant heat of the fire bed. The tubes marked "S" receive the saturated steam directly from the boiler, while the tube marked "W" receives cooling water from the boiler or boiler feed line. The steam tubes are recessed into the thick walled water tube and the interval between the steam tubes is filled with weld metal. The large area of weld metal is greater than would be required to maintain the steam tubes in position, but is added to insure maximum heat transmission from the steam tubes.

It is well known that heat tends to flow in the direction of greatest temperature drop and that more heat will be absorbed by a heavier section. In this case, the temperature drop is through the heavy weld section between the steam tubes. This means, in effect, that the weld section in contact with the steam tubes does not add to the superheat, but conducts the heat impinging upon it directly to the cooling tube inside. The area of the steam tube contributing to the superheat of the steam is the approximate one-half not connected directly to the cooling tube by weld metal. If operating conditions are such that it is unnecessary to use water in the cooling tube, the path of heat flow will be to the steam tube and all the impinging heat will be used in superheating.

It will be noted in Fig. 1 that the steam tubes are recessed into the water tube, so that about 1/3 the area of the steam tube is only touching the water tube and is not intimately connected to it by welding. This recessing of the tube accomplishes two objectives: first, it serves to locate the steam tube and facilitate fabrication; but, more important than this, it provides an air gap between the steam tube and the water tube and prevents desuperheating of the superheated steam. This fact is important because it allows the saturated steam to be fed at either end of the superheater to accommodate a particular boiler design. Incidental to the above, the recessing of the steam tubes makes for better welding by eliminating the very narrow V that would result if the small tubes were welded directly onto the large tube.

In the installation of the superheater in the boiler, the units are inclined at an angle to the horizontal and the height of water maintained in this column regulates the area of tube used for superheating. The slower the feed of cooling water the greater the proportional vaporization of cooling water in the high end of the tube and a greater length of small steam tubes will become effective in superheating.

*This is a paper submitted by the author in the H1 classification of the $200,000 Program sponsored by the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, in which savings of $1,600,000,000 were shown available to industry by wider application of arc welding.

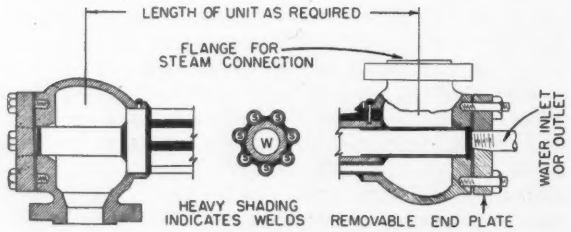


Fig. 1. Sections through parts of Turner superheater

Figure 1 is a longitudinal sectional view of the unit, showing the assembly of the steam headers on the ends of the tubes and the inlets and/or outlets for water and steam. The steam headers are of spherical shape and so are necessarily steel castings. The headers are keyed and welded onto a collar which has been built up flush with the outside of the steam tubes by welding.

Cooling water flow may be controlled manually with a simple globe valve, or automatically with a thermostat in the steam line.

Welding the Superheater

All the welds connecting the headers to the tubes are simple fillet welds and require only good welding technique to be made satisfactorily. The most difficult welds, from the fabricating standpoint, are the long fillets connecting the steam tubes to the water tube. The first problem to overcome was excessive warping due to shrinkage stresses in the welds. It was found that if a weld was run continuously, on one side of the water tube, on completion the assembly would pull out of shape as much as 2½ or 3 feet. Various schemes of welding to eliminate distortion were tried, such as step welding and peening, etc., but the scheme that seemed to give the best results and required the least cold straightening was as follows:

First, the heavy walled water tube is milled out to accommodate the steam tubes. The smaller diameter steam tubes are assembled in their respective grooves and held in place with ring clamps. Welding is begun in the center of the assembly and carried about a foot each side of the center line. The distance between two adjacent steam tubes (⅜ in.) is filled with one pass and the steam tubes are welded to the water tube. This first bead serves two purposes; it welds the steam tubes to the water tube, thereby determining in its depth of penetration the lower part of the path of heat flow from the steam tubes to the cooling water; secondly, it builds up the thickness of the water tube and serves to widen the fillet angle between the steam and water tubes. After this first bead is deposited and properly cleaned, fillets are welded well up on the sides of the steam tubes and are lapped one over the other in the manner shown in Fig. 2. This procedure produces the smooth curving surface required for proper heat distribution.

After this section is completed for a distance of about 2 ft., the assembly is turned bottom up and the same procedure followed. This system is carried out on diametrically opposite sides of the assembly until the center section is welded completely.

The rest of the job is welded in steps in the same manner as the center section.

This system of welding, although it entails considerable care and handling, has eliminated most of the serious warping and reduced the necessity of mechanical straightening to a minimum.

Again it must be emphasized that this remarkable contribution to boiler design became practicable through the use of welding. In this case, as in many others, the development of welding from the hit-or-miss guesswork of a few years ago to the predictable, usable tool it is today, is responsible for the production of better, cheaper and more efficient design.

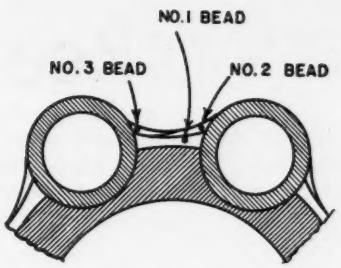


Fig. 2. Manner of welding superheater tubes

Safety Precautions for Hand Tools

APPARENTLY harmless hand tools are the cause of a surprisingly large number of accidents. Observance of the following precautions given by the National Safety Council will help to prevent them.

Do not use a machinist's hammer to drive nails. Use a flat faced hammer.

Never use a hardened face hammer on a highly tempered tool such as a drill, file, die, jig, etc. Chips may fly.

Hammers with cracked heads and handles are particularly dangerous and should be discarded.

Use only wrenches that are the right size for the job and in good condition.

Avoid placing an adjustable wrench on a nut so the jaws are facing in the opposite direction to the pull.

Never apply a wrench to the work in a lathe or similar machine while it is in motion.

See that pipe wrench jaws are sharp and chains in good condition so they will not slip.

Keep chisels, draw knives, axes, adzes and similar tools sharp. A sharp tool is safer and more efficient than a dull one. Keep them in a safe place when not in use.

Never attempt to use a draw knife by bracing the work with your knee.

Always wear goggles when using cold chisels, bull chisels and other tools that produce flying pieces.

Never use tools with mushroomed heads because of the danger of flying pieces.

Never use a file or wood chisel without a handle.

Avoid using a screw driver in such a way that if it slips you will drive it into your other hand.

Look out for broken or splintered wood handles. Always use the right tool for the job.

For grate bars, subject to sulphur gases and considerable shock, after trials of several alloys an iron of the composition; Carbon, 2.9 to 3.3 per cent, Silicon, 2.2 to 2.8 per cent, Manganese, 0.6 to 0.8 per cent, Nickel 0.7 to 0.8 per cent, Chromium, 0.7 to 0.9 per cent was found to increase durability 4 times over unalloyed iron.

Readers' Conference

These pages are open to readers for the presentation or discussion of any timely power plant topic. The Editors invite your participation.

Aids for Packing Governing Valves

WE RECENTLY developed these fixtures for packing governing valves on our Curtis type turbines. They proved to be well worth their construction cost and have saved burned fingers, banged knuckles and lots of time in the few months we have had them.

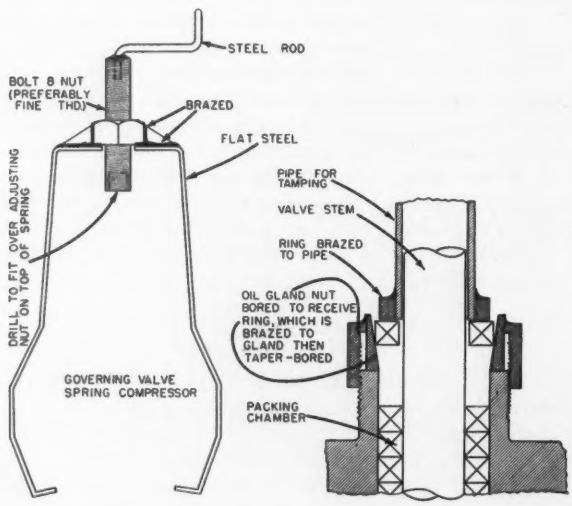
The spring compressor was developed to eliminate the use of two large bolts for removing the spring on top of the valve. Flat steel, ¼ by 1 in., formed the legs, which were bent to slip over the valve lifting arms and hook under them. A bolt and nut from an old steam pipe flange were put in place as shown by brazing. Triangular pieces or gussets were also brazed in for added strength. The end of the bolt is bored to slip over the spring tension adjusting bolt head. This feature is important as it keeps the spring from hopping out when under tension. A handle is bent and brazed as shown.

The other cross section shows two handy fixtures. The pipe for tamping is perhaps a common tool. A ring brazed to the bottom will improve the packing job.

Packing as received is usually a tight fit in the packing space. Formerly we flattened the packing to facilitate its insertion. The new "funnel" idea pictured is easier and better. An old gland nut is bored out, and a bushing inserted as shown, then brazed together. The nut is then chucked in the lathe, and bored tapered. An increase in diameter of ⅛ in. from bottom to top will be found sufficient. To use, just screw on in place of the gland nut, drop rings of packing over stem and tamp each one separately.

These tools have proved a big help to us. Our valves have stems 1¼ in. diam. and use ½ in packing. The materials used should be strong enough for the spring size. We feel sure many others will be glad to know about these simple but efficent tools.

New Haven, Conn. R. L. WILLIAMS.


STEEL ROD
BOLT & NUT (PREFERABLY FINE THD)
BRAZED
FLAT STEEL
PIPE FOR TAMPING
VALVE STEM
RING BRAZED TO PIPE
OIL GLAND NUT BORED TO RECEIVE RING, WHICH IS BRAZED TO GLAND THEN TAPER-BORED
DRILL TO FIT OVER ADJUSTING NUT ON TOP OF SPRING
GOVERNING VALVE SPRING COMPRESSOR
PACKING CHAMBER

Spring Compressor and tapered gland nut have made packing turbine governing valves easy

Pressure Reducing Valve Troubles

THE FAMILY doctor examines, diagnoses, prescribes; he does so calmly and unhesitatingly. Likewise the engineer, called in to remedy some perplexing and unprofitable condition, must do so quickly and correctly. Each must think on his feet, so to speak, lest they lose the confidence of patient or customer, and each must draw on his experience, coupled with common-sense fundamentals. Witness two incidents following, both involving valve size, in one case too small and the other too large.

The boss said, "Go down to the B—— building, they're having trouble with a pressure reducing valve."

Contacting the engineer of the building, the latter explained the difficulty. "We have a reducing valve taking off from the main header from the boiler and controlling flow to the heating mains. The valve reduces an initial pressure ranging from 90 lb. to 120 lb. down to 5 lb. Naturally we want a nearly constant pressure of 5 lb. in the heating system—but look." He walked across the room and stood before a flow meter mounted on the wall. The pen line indicated erratic peaks and depressions of flow in short-spaced fluctuations.

"Look at the pressure," and he pointed to a pressure gage mounted alongside the flow meter, the indicating hand making wide swings back and forth from 2 lb. to about 10 lb.

"Let's see the valve," remarked the valve engineer, sensing a familiar situation.

"Sure, this way."

Presently we stood before the valve. "H'm! Valve same size as the line," remarked the valve man. The building engineer merely looked blank.

A call to the factory brought forth the information that the valve had been purchased and installed by a heating contractor, who had merely ordered a 5-in. valve because the line size was 5 in., giving no other information than the initial and final pressures.

"What is your peak load requirement?" the engineer was asked.

"Well, 9000 lb. steam per hour is a high maximum; about half that is the normal demand."

The valve man figured a few minutes. "A 2½-in. valve would have been sufficiently large to handle the peak," he said. "This valve is about 400 per cent oversize."

The valve "insides" were replaced with special parts which reduced the port area to an equivalent 2½-in. valve area. Thereafter, in operation, the flow meter registered high and low demands according to requirements, but the pressure gage held almost constant on the 5 lb. reading.

The valve being so greatly oversized caused the disc to hover close to its seat at all times, rapidly opening and closing, but operating only about 20 per cent of its travel to handle the maximum load. This condition causes a chattering noise, wire drawing and short valve life. The smaller port area permits the valve to function over its entire lift and therefore produce efficient service.

The second case involved a call to a bakery in an outlying district. Here again the complaint was erratic functioning of steam pressure, in this case to control temperature at the ovens.

The bakery generated its own steam with a low pressure boiler, about 15 lb. maximum, but at peak demands the load pulled the boiler pressure down to as low as 5 lb. Both line size and valve size was 2 in. Pressure requirements at the ovens was 5 lb., and obviously was required to be constant.

The valve had been ordered on the basis of delivering 1000 lb. steam per hour maximum at 5 lb. downstream (to ovens) with initial pressure in excess of 10 lb., allowing a 5-lb. drop across the valve. Satisfactory performance was obtained so long as boiler pressure was maintained at or above 10 lb., but the reduced or controlled pressure fell rapidly at peak demands whenever boiler pressure fell below 8 lb.

A few calculations sufficed to ascertain that the line was sufficiently large to pass maximum demands, but that the pressure drop across the valve fell too low at peak periods. The fact that the boiler was unable to maintain a 10-lb. pressure at peak loads had not been noted previously; the valve was blamed instead.

The average reducing valve will pass no more than 50 to 60 per cent of equivalent line size capacity, under comparable conditions, and to balance line flow the reducing valve will require greater pressure drop than the line in order to pass the load required. This is so even though the port area of the valve exceeds the pipe line transverse area. Several changes in direction of flow in the reducing valve web and ports is responsible for this condition. And it is well to remember that while flow is directly proportional to area or velocity, yet pressure drop is proportional to the square of the velocity.

Under these natural conditions, if flow through the valve is only 50 per cent of requirements, we must either double our valve port area or double our velocity. To double velocity we must multiply present pressure drop by 4. Obviously the boiler was incapable of maintaining pressure sufficient to provide proper pressure drop at the valve during peak loads and the only recourse was to advise a larger size valve.

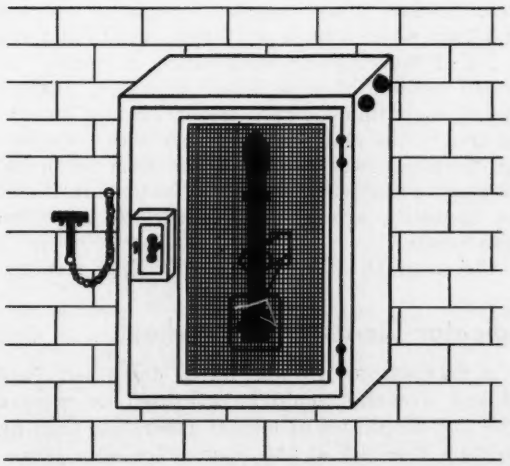
A 2½-in. valve has an increase in area of about 70 per cent over a 2-in. size. The 2½-in. valve was installed, replacing the 2-in. size, and satisfactory performance resulted.

Philadelphia, Pa. W. F. KAY.

Tamper Proofing Main Circuit Breakers

WHERE the services of an electrician or switchboard operator are not available at all times, as is frequently the case in many small manufacturing plants using purchased electricity, a readily accessible means of interrupting the incoming power circuit should always be provided in order that accidents to personnel and equipment can be prevented or, if they should occur, their effects minimized. Making this switch completely accessible has its disadvantages, however, among which are the danger of production interruptions caused by some object striking the operating mechanism and tampering or unnecessary and unauthorized operation. Danger of the switch or its tripping mechanism becoming inoperative is another factor that must be considered, especially where the surrounding atmosphere is contaminated with dust, vapors, or corrosive agents.

All of these hazards have been guarded against in one small plant by protecting the operating lever of the incoming power oil circuit breaker in a novel manner. This lever, mounted on the outside wall of a fireproof compartment housing transformers, the breaker, and other high voltage equipment is surrounded by an asbestos board lined enclosure having a door with a window protected by a woven wire screen. This door is equipped with a locking arrangement similar to those used on fire alarm boxes having a bolt that is operated by a handle enclosed in a small box with a breakable glass front. Under normal conditions the handle is made accessible by unlocking this front with a key. When an emergency develops and no key



Tamper proof circuit breaker

is at hand the switch lever is reached by smashing the glass, turning the handle and opening the door of the main enclosure. A small metal hammer fastened to the side of the enclosure with a length of chain is provided for this purpose. Position of the switch operating lever is visible at all times through the large glass window of the door. Wire screen covered ventilating openings in the bottom and sides of the enclosure take care of any heat generated by the trip coil.

Roanoke, Va. S. H. COLEMAN.

Sand Helps Lick Water Main Electrolysis

DUE TO the presence of stray electrolytic currents and soil of a corrosive chemical nature, several section of an 8-in plain cast-iron water main of the Reliance Electric & Engineering Co. of Cleveland, Ohio, developed severely corroded pits in their surface and eventually leaked to the extent that the sections had to be replaced.

The soil about the pipe was wet, indicating poor drainage conditions, and varied from dark-colored clay to black muck. It was examined by a chemist and found to be distinctly alkaline. Tests for stray electrolytic currents revealed potential differences in the soil of as much as 50 millivolts.

Although only a few sections were affected, it was evident, because of similar unfavorable soil conditions all along the main, that leakage might be expected at other points unless all the pipe sections were treated.

To remedy these conditions it was decided to remove all the soil within at least a foot and a half of the pipe which lay from 4 to 8 ft. underground. To reduce electrolytic action the pipe sections were then electrically connected by means of a bare No. 6 copper wire running the whole length of the main. This wire was attached to each section with ground clamps and —as a further precaution—carefully grounded again at both ends of the water line.

Treatment of the pipe surface itself was not overlooked. It was first painted with hot asphalt, then wrapped with asphalt-impregnated paper, and painted again with more hot asphalt.

Of equally great importance, the soil which had immedately surrounded the water main was not put back. Instead, it was completely replaced with a dry sand loam, secured from a different locality altogether.

All of the forgoing work called, of course, for a certain amount of excavation. However, instead of digging a continuous, open trench through the working area of the plant, interferences with manufacturing operations was held to a minimum by breaking holes in the concrete floor only at 15 to 20 ft. intervals and tunneling around the pipe which lay between these points.

Cleveland, O. F. M. CARVER.

Indicator Cards From Flywheel

A TELEGRAPHIC request for a dozen left handed monkey wrenches could have caused no more surprise and suspicions of mental abberation than did a telegram received at the main office of a large industrial corporation from the young Chief of their new midwestern branch plant. The telegram read, "Indicator cards from flywheel number one Corliss show dangerous condition immediate new wheels necessary letter follows."

The follow up letter with the indicator cards and the story that these told resulted in the immediate dispatch of the engine builder's Chief Designer to the field, a verification of the situation and a prompt delivery of new, heavier flywheels for two Corliss engines at no cost to the purchaser.

This occurrence was "away back when" alternating current was in its beginning for industrial plant service and before direct connected engine-generator units and steam turbines were in vogue. The plant construction work was about completed and two Corliss engines were being installed in the power house for rope drive connection to a.c. generators for power and lighting service to the group of buildings comprising the plant.

The erection of the engines was completed; they were being turned over for a few days without load and the boss painter had taken particular pains to give them a fine, glossy dark green paint job, gold striping them himself at the week end.

On the Chief's first round on Monday morning the engines were neat and running noiselessly at speed. A fine looking job. But as he noticed the narrow gold stripes on the sides of the flywheel rims he registered a suspicion that the old boss painter's hands were getting a little bit shaky. This suspicion he conveyed, possibly with a little more sarcasm than charity, to the old and faithful boss painter who just then appeared nearby, eager for the Chief's approbation. "But, Chief," said the bewildered and crestfallen old painter, "those stripes were sure true when I laid them on. I just held my brush tight on that hand railing while Jim turned her over very slow. Yes, sir, they sure were true." A bright light suddenly illumined the situation and the Chief's mental conclusion was verified when Jim alternately slowed down and sped up the engines, for the wabbling of the gold stripes disappeared with the slowdown and reappeared as the engines attained speed.

Flywheel rims that bulged in evident humps between the spokes were something serious and called for quick action and report. But the word of a young Chief, only recently on the job, needed, he knew, some positive backing in the way of visible evidence to stimulate the heads at the main office to prompt action.

The vibration of a pencil held firmly on the hand railing with its other end bearing against the turned wheel rim suggested a procedure which resulted in the flywheel indicator cards. A small wooden shelf was attached to the adjacent railing and extended alongside of the flywheel rim. On this was mounted, horizontally, an L shaped lever member of light steel plate. This was pivoted at its corner and had the extremity of a short leg bearing on the circumferential edge of the turned wheel rim, while a longer leg extended lengthwise of the shelf. A rubber band held the short lever arm in position against the wheel and any bulging of the rim was multiplied in the motion of the end of the long arm. Here a pencil

point was attached and just below the pencil the indicator with its reducing gear was mounted horizontally, using a threaded fitting and wood bracket for attachment to the shelf.

A light cord was given one loose turn around the engine shaft and its end on the "pulling" side was attached to the indicator cord hook by a weak link of light fuse wire. When the free end of the cord was pulled taut the rotation of the shaft caused the indicator drum to make one revolution at the end of which the fuse wire broke and the moving pencil point had recorded two revolutions of the flywheel.

The wheels were made in two halves, bolted together midway between two of the six spokes. The cards taken at engine speed showed six nicely curved "humps" per revolution, two of them being higher where the joints occurred. Below, as a "base line," was a nice straight line showing the rims condition as indicated when the engine was just turned over slowly.

This evidence was quite conclusive when received at the main office and the engine builder's prompt replacement of the wheels was accompanied by their acknowledgment of a serious miscalculation on their part. Their rope-grooved wheels thereafter had more stock in the rims.

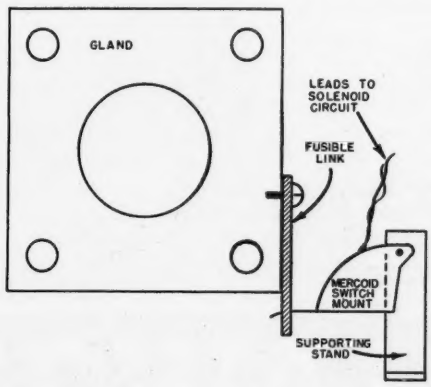
Washington, D. C. HOBE STEVENS.

Fusible Link Protects Isolated Pumps

PUMPS handling petroleum or those of its products with lubricating qualities still therein rely upon those qualities of the fluid being handled to prevent undue friction, and when a break in suction results in starving the pump, serious wear or even breakdown can occur.

One company using a number of both plunger and positive pressure rotary pumps for this service uses a fusible link and a mercoid switch to provide an economical and yet effective shut-down device in case the human supervision of the unit fails or is otherwise engaged.

A link (usually of the 135 deg. Fahr. type) is attached to one side of the packing gland with a stove bolt, paint on the gland being removed to insure close contact between link and gland. In the lower eye of the link is hooked the support of a mercoid switch, swinging from a convenient bracket and with its leads running to a solenoid. In case of overheating, the solenoid will open, drop the switch, and the solenoid will be energized, closing the fuel line or opening a power switch, depending upon the type of prime mover driving the pump.



Fusible link used as a protective device on a pump

The fusible link is not nearly as expensive as a thermostatic protecting device, and does not require as careful installation and handling, but is effective for protecting the type of pump described.

Longview, Texas. ELTON STERRETT.

Small Plant Economics

FAREL A. H. HULLICK, who describes the rehabilitation of a power plant in which the fuel is a gift of providence, almost captions that article with the assertion that: "Isolated power plants, particularly those in industrial service, are not economical by comparison with purchased power if true cost could be ascertained."

That is a statement which surely does not apply to this section of the country where some sense of heat conservation is prevalent. In this section we need heat for our buildings at least six months of the year and the cost of power during that period can be ascertained.

The Corliss engine referred to is about 150 hp., which at full load will nearly supply sufficient exhaust steam to heat a small size factory.

Let us determine the cost of power during the heating period: We know that the latent heat is about 966 B.t.u. per lb., adding 150 lb. boiler pressure 1116 B.t.u. If the pressure on the heating system is 5 lb., then we get our 150 hp. at a cost of 145 B.t.u., the 971 B.t.u. being profitably used in the heating system.

This analysis clearly shows that the engine develops 150 hp. while acting as a reducing valve for the heating system and the power becomes a by-product because the heat is an absolute necessity to enable the people working to produce profitably.

During the summer months a multitude of mills use this latent heat to great advantage.

We will all agree that even the specializing efficiency expert rides around on the city's streets propelled by an isolated power plant at 25 per cent efficiency, nursing his rugged individualism without a thought of the advantage of the public utilities.

An isolated power plant is a sign of independence, and if the owner is a little scientifically inclined, the possible efficiency would be that which the central stations hope to reach.

Philadelphia, Pa. B. HJORTH.

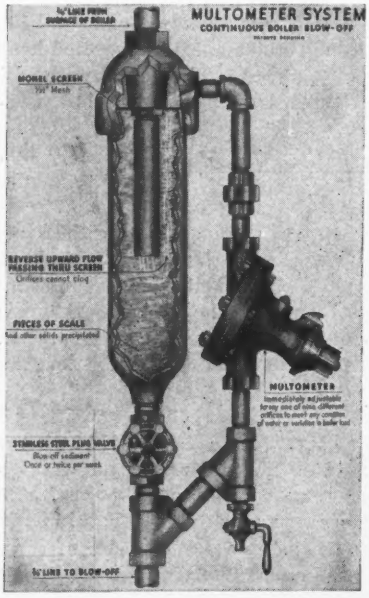
IN GENERAL, the water wetting test is a useful and simple way of proving whether a surface is free from oil. If a surface, say of glass or steel, carries a film of oil even as thin as one molecule, and is then flooded with water, and shaken, the water will run off, leaving the surface apparently dry. But if an adherent film of water remains, it proves that the surface is relatively free from oil or grease.

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Continuous Blow-Off

OFFERED by P. E. Madden & Co., 352 W. Walton St., Chicago, Ill., and sold under the trade name Multometer System, this new type of continuous blow-off incorporates a novel separator which prevents clogging of even the smallest orifice. A new type of control consisting of a stainless steel cone drill with nine orifices of any desired size is another feature of this equipment. The Multometer System is available in several



forms, including a small compact unit for the control of blow-off only or in combination with either flash tanks or heat exchangers or both.

Time Switch

APPLICABLE in the many instances where a simple time switching operation is required, Type S403A Timer, a product of Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., has been designed primarily to control the operation of electrical equipment with a non-inductive load of 10 amp. at 110 v., 5 amp. at 220 v. or motors of 1 hp. repulation induction, ½ hp. split phase, or ¼ hp. direct current, either 110 or 220 volt rating. The Timer may be manually set to close the circuit and will automatically break the circuit at a predetermined time for any period from ½ hr. to 11 hr. Merely twisting the knob on the front of the Timer until the desired time interval appears on the dial puts it into operation. The timing mechanism cannot be overwound so that it sticks, and a twist of the knob in the counter-clockwise direction will turn the current off at any time it may be necessary.

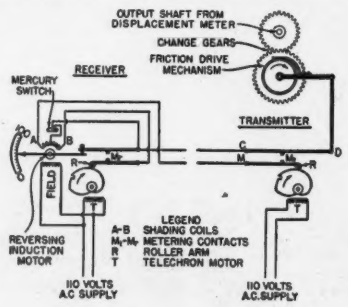
The Con-Tac-Tor mercury switch used to make and break the circuit is of such a design that leveling by sight is sufficient in making the installation. It

is not necessary that the instrument be mounted in an absolutely perpendicular position. The Timer is arranged for mounting on a standard switch outlet box and is provided with knock-out for wire mould or regular conduit so that either concealed or exposed wiring may be used, thus making it adaptable to old or new installations.

Flow Recorder

DEVELOPED by Bailey Meter Co., Cleveland, Ohio, this new flow recorder employs the Bailey Synchro-Meter electrical transmitting method, differs from the usual flow recording attachment for displacement meters in that it draws a graph of rate of flow against time instead of simply recording total flow over a given time. It is attached to the displacement meter body by employing the flange bolts. The displacement meter register is raised by a filler block to afford room for bevel gears and a short shaft extension is used to drive the register of the displacement meter. The bevel gears drive a shaft which operates the Synchro-Meter unit.

As will be noted in the diagrammatic drawing, the contact arm CD is connected to a friction drive mechanism so that operation of the displacement meter



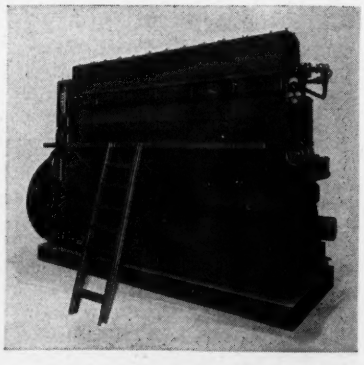
causes it to descend until contact Mt is made. Contact Mt remains closed until the constant speed cam driven by Telechron motors T reach their maximum throw. The constant speed cams are shaped so that the roller arm Mr descends more rapidly than the friction driven contact arm CD so that the latter is free to descend a distance proportional to the rate of flow through the displacement meter.

The recording and indicating instruments of the receiver are positioned by a reversing induction motor which runs in one direction when shading coil A is short circuited, and in the other direction when coil B is short circuited. The circuits through these coils are closed by contact Mt in the transmitter and Mr in the receiver.

This Synchro-Meter device is particularly useful when it is desired to indicate and record the instantaneous rate of flow of fluid which cannot be satisfactorily measured by orifice type meters and may also be used as a tachometer for indicating or recording the instantaneous speed of any rotating shaft and is especially desirable for low speed (1 to 5 r.p.m) measurements.

Diesel Engine

WORTHINGTON PUMP & MACHINERY CORP. of Harrison, N. J., recently announced its new type CC totally enclosed, direct-injection Diesel engine developed for installation where continuous, heavy duty loads are to be carried. It is applicable to municipal and industrial plants and is an ideal peak-load unit for larger plants having other types of prime movers. It is adaptable to pumps, compressors



and other power drives. It is particularly suitable for rock products plants, oil field work, grain mills, excavators and other similar installations where quantities of abrasive materials may be present in the air.

Of the four-cycle, trunk-piston type, using a direct fuel-injection system, the new engine is of simple and compact de-

Photo News Valve values

TITLE REG. U. S. PAT. OFFICE AS TRADE MARK

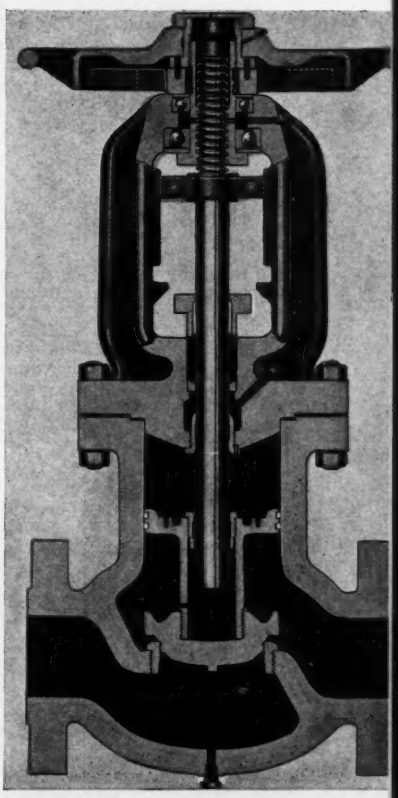
THE EDWARD VALVE & MFG. CO., INC. • EAST CHICAGO, INDIANA

STANDARDIZED -- BUT INDIVIDUALIZED!

EDWARD VALVES WILL CONFORM TO THE RECENTLY ISSUED AMERICAN STANDARDS BUT WILL RETAIN THEIR OWN IDENTITY. ALTHOUGH COMPLYING WITH APPLICABLE SPECIFICATIONS — WHETHER COVERING DIMENSIONS, CHEMICAL AND PHYSICAL CHARACTERISTICS, METHODS OF TEST, OR WHAT NOT — THERE STILL REMAIN THOSE VALUABLE THINGS WHICH REPRESENT THE BUILDER'S INITIATIVE AND EXPERIENCE AND PROVIDE CRITERIA BY WHICH TO JUDGE TRUE OPERATING VALUE OF THE PRODUCT.

HERE ARE SOME REASONS WHY.

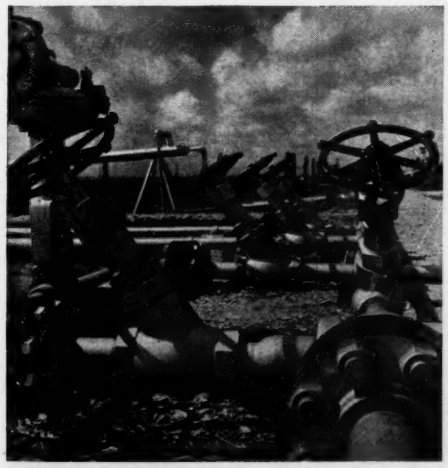
Edward non-return valves typify designs which conform to ruling standards but are individualized in detail. Standard as to controlling measurements, they are built under increasingly severe laboratory control to meet newest needs for high superheat and top pressures. Body guide ribs keep operating parts centered but without lodging space for foreign matter. Disk-piston unit is necked-in for free steam flow above disk as well as around disk, to avoid pressure loss from conflicting currents. EValloy piston rings reduce shock. Simplicity in all details. Impactor handwheel is valuable for closing the valve against test pressures, as well as for normal operation. It is a great boon to the operators, as has been proved in many plants.



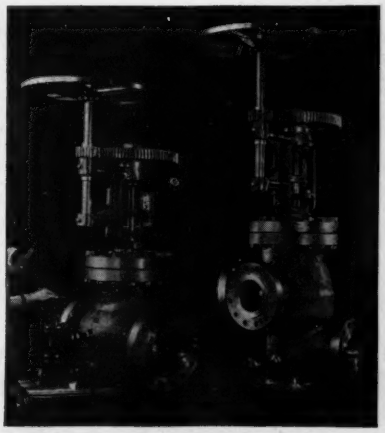
BEVELS FOR WELDING.

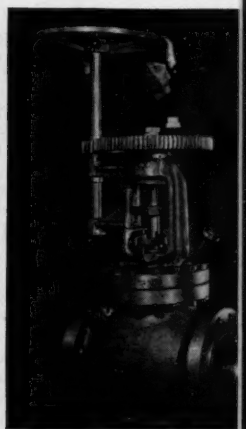
Recommended practices for machining welding ends are found in the new A.S.A. standards. A straight bevel is preferred for welding ends for thicknesses $\frac{3}{16}$ to $\frac{3}{4}$ in. and a U-bevel for thicknesses greater than $\frac{3}{4}$ in. For small forged steel valves, although not yet covered by standard, present trend is toward socket ends. Cut shows how welding bevels are machined on Edward assembled and tested steel valves.

EVERYTHING UNDER CONTROL 'NEATH TEXAS SUN.



Edward forged and cast steel valves find important uses under the blazing Texas sun. In petroleum refineries as well as in production work, Edward valves are available in a variety of designs, materials and types. Edward relief valves, for the protection of pressure vessels, are constantly gaining wider use. For steam service in boiler house or in the field Edward valves help keep up production without lost time.





SPECIAL CAST STEEL VALVES FOR HIGH SEAS. On shipboard, space sometimes forbids use of standard sizes and types. Witness the Edward cast steel valves above especially built for ocean liner. The fundamental features of regular valves were retained.

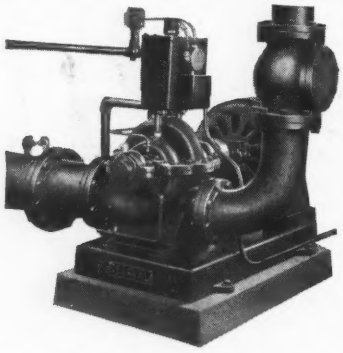
EDWARD VALVES

Stop · Check · Blow-off · Non-return · Feed Line · Relief · Bleeder Line · etc.

sign consistent with high efficiency and complete accessibility. All moving parts are wholly enclosed. The cone-type cylinder head featured in the CC engine has eliminated the possibility of head breakage due to load and temperature stresses. Full provision for expansion is made in this construction, and the need for a gasket between the cylinder head and the liner is abolished. The lubrication system of the engine has been developed to a degree not exceeded by any other oil engine. All moving parts are pressure-lubricated. The main bearings receive their supply of oil from a cast-in, jointless oil pipe in the base. Positive sight-feed lubrication of cylinder walls is also provided. Liberal oil storage is built into a deep sump in the base beneath the screens.

Pump Primer

WITH a new system of priming centrifugal pumps which has been developed by the De Laval Steam Turbine Co., Trenton, N. J., the water level in the suction space is raised above the center of the pump when the pump is initially put into service, thereafter, the entire suction line and the pump casing are normally kept full of fluid, so that discharge begins immediately the motor is



started. If for any reason the priming should be lost the pump motor is at once shut down until the water level has again been raised above the pump suction opening.

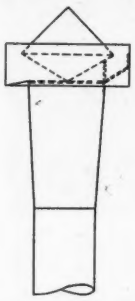
A priming chamber, mounted above and on the pump casing, contains, or is connected to, an air evacuating device, consisting ordinarily of a simple water, air or steam ejector drawing from the priming chamber through a check valve and discharging to waste at some convenient point. The starting by a valve opthe ejector is controlled by a valve operated by a solenoid energized from an electrical device which responds to the water level within the priming chamber, this same device also controlling the starting and stopping of the motor driving the main pump.

The governing impulses originate from two electrodes which enter through the top wall of the priming chamber with insulating bushings, similar to spark plugs, and terminate at different levels in the priming chamber. The electrodes are connected to one terminal of the secondary circuit of a small A.C. transformer, the priming chamber itself being connected to the other terminal, while the circuits of which they form parts include a magnetic relay which is so arranged that the ejector will be started, and the pump motor prevented from operating, whenever the water level falls below the lower electrode, while the vacuum producer will be shut down and the pump permitted to operate when the water reaches the upper electrode.

Where the main pump can, without danger, be operated dry the De Laval submerged suction priming equipment may be arranged to prime the pump while running, requiring only a slight change in the electrical and sealing connections. In some cases, with belt or engine drive, or where for any other reason it is impracticable to shut the pump down on loss of priming water, De Laval pumps are so equipped that they can operate unprimed and without injury during the time required for the submerged-suction priming system to remove the air and to elevate the suction water level above the pump suction. This feature is valuable where the pumps are driven by synchronous motors with a limited "pull-in" torque, as the pump can be started with the casing air-filled and the submerged suction priming system put into operation by a suitable relay only after the driving motor is locked in synchronism.

Smokestack Protector

J. T. CULLEN Co., Whiteside County, Ill., announces a new patented smokestack protector for weather proofing smokestacks. This protector consists essentially of a Venturi tube, two conical sections and a circular guard band. The purpose of the Venturi tube is to increase the natural draft; the conical section which the apex upward acts as a watershed while the inverted conical section serves to spread the products of combus-



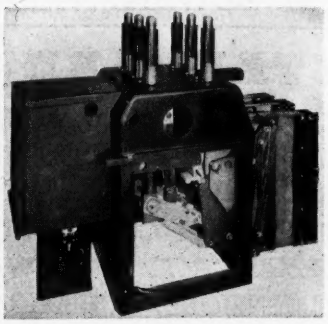
tion to the atmosphere; the guard band prevents the elements from entering the interior of the stack from the side. It is said that the Protector prevents moisture from entering from the top of the stack and lessens corrosion due to sulphuric acid; stimulates natural draft; eliminates dangerous downdraft; and acts as an efficient spark arrester. Since its introduction a few weeks ago several installations have been made in utility plants in the Central Illinois area.

"Magne-Blast" Air Circuit Breaker

A NEW air circuit breaker is announced by the General Electric Co. for use with its standard, vertical-lift type metal-clad switchgear. Called the "Magne-blast," the new breaker has been developed for 5000-v., three-phase service.

Unique interrupting characteristics are claimed for the new breaker. When the contacts part the arc is magnetically driven into a specially constructed chute which confines and speedily interrupts the arc. This operating principle so improves the power factor of the fault that when interruption occurs the power factor at interruption is close to unity.

Rate of rise of recovery voltage is only a fraction of the inherent characteristics. Tests indicate the breaker is especially well suited to the interruption

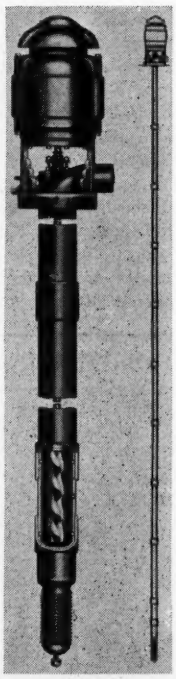


of highly inductive a-c circuits and is independent of the recovery characteristics.

Main contacts are silver-to-silver and the arcing contacts are of silver alloy. The studs of the breaker are the male ends of the disconnecting devices and have silver contacts to eliminate periodic maintenance.

Deepwell Pump

HI-LIFT is the trade name given to a new pump recently put on the market by the Peerless Pump Diivision of the Food Machinery Corp. While the design is an innovation, it is simple and the manufacturer states that the principle has proved thoroughly satisfactory and practical by tests and service. Details are available from the Peerless Pump Div., Department 195, 301 West Avenue 26, Los Angeles, Calif. One of the outstanding advantages of the new pump is its ability to obtain maximum capacity from drilled deep wells as small as 3 in. in dia. and with lifts ranging from 40 to 1000 ft.



From an engineering standpoint the Hi-Lift is neither a turbine nor a plunger pump but consists of a cutless rubber stator and a spiral shaped rotor of stainless steel, heat treated and chrome plated. Capacities start at 5 g.p.m. and pressures in excess of 500 lb. are obtainable. The small element will lift 50 g.p.m., 200 ft. Two of these elements will lift the same quantity 500 ft. It is said that to accomplish this with the small capacity deep well turbine pump would take from 50 to 100 separate pumping elements operating at the same speed of 1760 r.p.m.

This risk is no longer necessary!
"EMBRITTLEMENT" TRACED TO BOILER CLEANING METHODS
Warn Against Soda Ash and Caustic Soda

Cook Out Your Boilers with NALCO No. 81

1. When starting up new boilers

2. After repairing old boilers

RECENT research work has disclosed that cooking out new or repaired boilers with soda ash or caustic soda to remove grease and oil is a practice that can lead to caustic embrittlement of the boiler metal. To protect owners of boiler plants against this hazard, the National Aluminate laboratories developed a preparation designated as Nalco No. 81. In addition to its anti-embrittling properties, No. 81 is a superior oil emulsifying agent—five times as effective as caustic soda! Complete information on how to use this product will be supplied on request. NATIONAL ALUMINATE CORPORATION, 6224 W. 66th Place, Chicago, Ill.

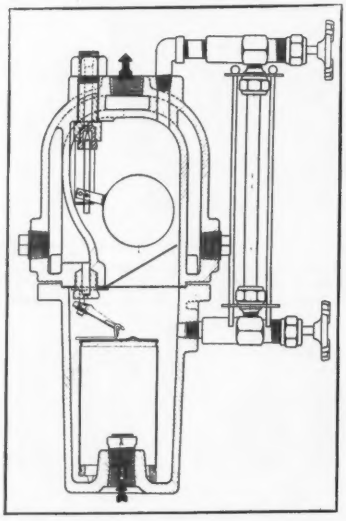
ANY WATER **NALCO SYSTEM** ANY PRESSURE

Inquiries other than domestic, *except those from U. S. Possessions, Canada and Mexico,* should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, Eng. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.

Gas Purger

DESIGNED to operate as a purger or as a combination expansion valve and purger, this unit made by Armstrong Machine Works, 810 Maple St., Three Rivers, Mich., removes air and noncondensable gases from refrigerating systems using any common refrigerant except CO_2; it works automatically without requiring operating attention after it has been placed in service, removes the air and noncondensable gases to near the vanishing point, and allows only a minimum amount of refrigerant gas to escape.

As shown in the cross section diagram, the unit consists of an inverted bucket and valve mechanism in the lower half

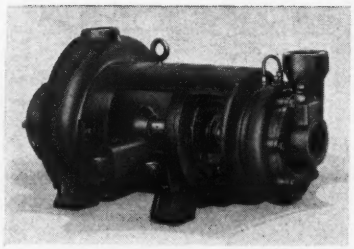


and a ball float and needle valve in the upper jacketed dome. It is connected to the high side receiver so it can take gas from the top of the receiver and just enough liquid from the bottom of the receiver to keep the cooling jacket filled. Refrigerant gas and a small amount of liquid refrigerant enter the purger at the bottom. The inverted bucket mechanism allows the liquid to enter the purger jacket at suction pressure, which causes the refrigerant to boil and chill the liquid within the purger dome. Gas passes through the vent in the inverted bucket and rises through the chilled liquid. The refrigerant gas will condense while the air present will collect at the top, depressing the liquid level until the ball float sinks and opens the air relief valve. When the air has been purged, all gas passing through the bucket vent will be condensed and the air relief valve hence will remain closed.

When used as a combination expansion valve and purger, the unit is connected directly to the bottom of the condenser. It takes the liquid refrigerant as fast as it forms and discharges it into the low side evaporator. This flow brings any air present into the purger, where it is collected and discharged from the upper chamber.

Centrifugal Pump

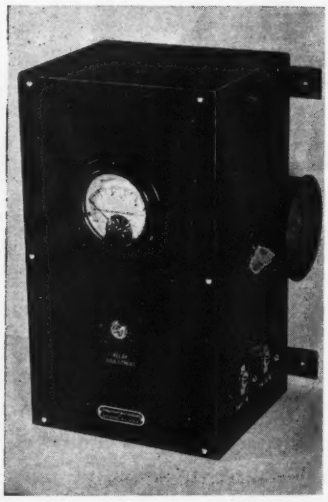
THE LATEST addition to the line of Monobloc centrifugal pumping units of the Worthington Pump & Machinery Corp., Harrison, N. J., is a group of compact turbine driven centrifugal pumps



which are ideally suited for conditions where fire and explosion risk from chemicals, gasoline, dust, oil or gas make other power units unsafe. The new units are flexible and applicable where only steam power is available. Capacities range from 10 to 400 gal. per min. at 10 to 240 ft. total dynamic head, with steam pressures ranging to 300 lb. per sq. in. maximum. Pump fittings may be had in standard bronze, iron or special materials.

Distilled Water Conductivity Checker

INDUSTRIAL INSTRUMENTS, INC., of Bayonne, N. J., announce the introduction of their type DW automatic distilled water checker, designed to measure the conductivity of water or other electrolyte continuously. Any change in conductivity from normal results in the operation of an alarm signal, electric



valve, or any other desired control apparatus. The meter on the instrument panel indicates the conductivity continuously.

For use with water stills or evaporators, the meter is calibrated in parts per million of chloride ions in pure distilled water. Installations of this type the DW checker is supplied with an electrically controlled valve which shunts the output of the still to drain whenever the purity of the water drops below required standards. Installed in the hotwell pump suction or discharge line the instrument serves as an accurate measure of condenser tube leakage.

This instrument is fully a.c. operated, and is equipped with a built-in voltage regulator to assure accurate calibration. Ruggedly built for severe industrial use, the control mechanism is housed in a steel cabinet 7 by 12 by 6 in. deep, equipped for wall mounting in any desired location.

Installation can be made by the plant electrician from complete instructions and circuit diagrams supplied with each instrument. The operating point of the relay used to control the alarm built on valves may be set for individual requirements by means of an adjustment on the front of the instrument panel.

The conductivity cell, which is used in conjunction with the control cabinet screws into a standard connection in the pipe line or tank containing the distilled water or electrolyte.

Refrigeration Controls

A NEW line of refrigeration temperature and pressure controls featuring the Hydraulic-Action principle is announced by Julien P. Friez & Sons, Division of

Bendix Aviation Corp., Baltimore, Md. Solid liquid charges, from which all gases have been excluded, actuate the switch contacts so powerfully that extremely high loads can be carried without relays, 25 amps. at 120 v., 15 amps. at 240 v.

Lubricators

DEVELOPED after several years of intensive laboratory research and practical tests, a new line of products which definitely inhibit rust and corrosion has been announced by the industrial lubrication department of the Standard Oil Co. of New Jersey and its Esso Marketers affiliates who will market them under the trade name Rust-Ban. These new coatings not only contain various conventional petroleum ingredients which themselves act as a protection against rust, but they also employ a new and special rust inhibitor which greatly increases this protection.

Having an extremely wide range of application these new non-drying coatings serve as a practical answer to the general problem of rust prevention by providing ease of application, low initial cost, durability, impermeability and sufficient elasticity to prevent cracking due to expansion and contraction with temperature changes. They also possess characteristics of freedom from hardening or cracking, peeling or slipping from the metal surface. They may be readily removed with petroleum solvents. Since these coatings provide lubricating films, they need not be removed for many subsequent uses of the treated part.

LUNKENHEIMER
BRONZE GATE VALVES

A Complete Line
for Steam, Water, Air, Gasoline and Oil Service

Fig. 2125
¼ to 3 in.
125 lb. S.P.
200 lb. W.O.G.

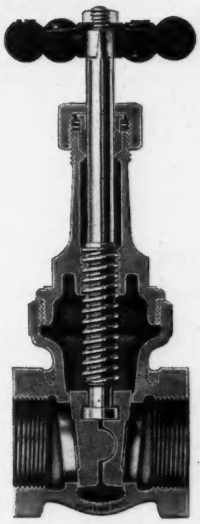


Fig. 427
¼ to 3 in.
150 lb. S.P.
300 lb. W.O.G.

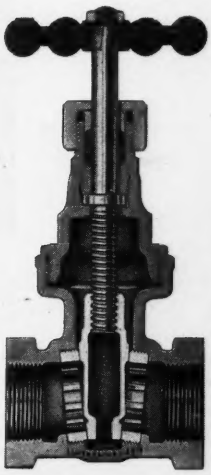


Fig. 768*
¼ to 3 in.
200 lb. S.P..
400 lb. W.O.G.

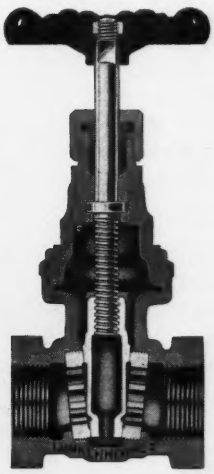


Fig. 771*
¼ to 3 in.
300 lb. S.P.
600 lb. W.O.G.

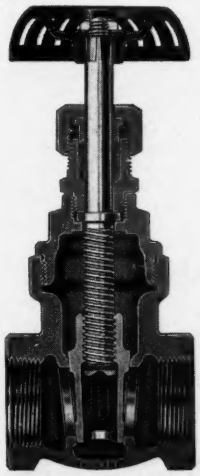


Fig. 2129
¼ to 3 in.
125 lb. S.P.
200 lb. W.O.G.

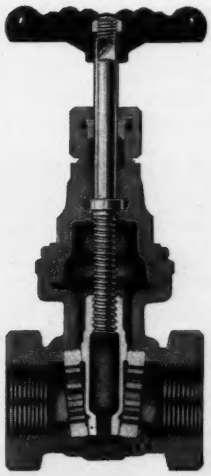


Fig. 1881*
¼ to 2 in.
350 lb. S.P.
1000 lb. W.O.G.

*Figs. 768, 771 and 1881 have renewable nickel alloy seat rings 1 in. and larger.

All patterns illustrated are also available with flanged ends.

ESTABLISHED 1862
THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
NEW YORK CHICAGO
BOSTON PHILADELPHIA
EXPORT DEPT 318-322 HUDSON ST., NEW YORK

BOILER MOUNTINGS — LUNKENHEIMER VALVES — LUBRICATING DEVICES

11012—47A—44

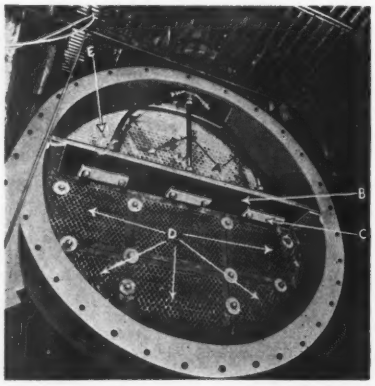
Water Gage Insert

MADE IN various lengths for any needed height of reading and in three designs for different pressures, Reliance Prismatic Water Gage Inserts, a product of The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland, Ohio, replace tubular glass with heat treated "safety" glass, reducing possibility of accidents and increasing reading visibility. Prismatic insert fits standard gage valves and may be used on any boiler, tank or vessel to read water, oil, ammonia and other liquids. Liquid level reading shows black, steam or air space shows white due to refraction of light. New housing design improves clamping action and makes glass replacement easy.

Air and Erosion Eliminator

THE AIR AND EROSION ELIMINATOR, a product of the Condenser Service & Engineering Co., 310 Twelfth St., Hoboken, N. J., consists of perforated screen plates placed in front of the tube sheet on the inlet end of condensers for the purpose of prolonging condenser tube life.

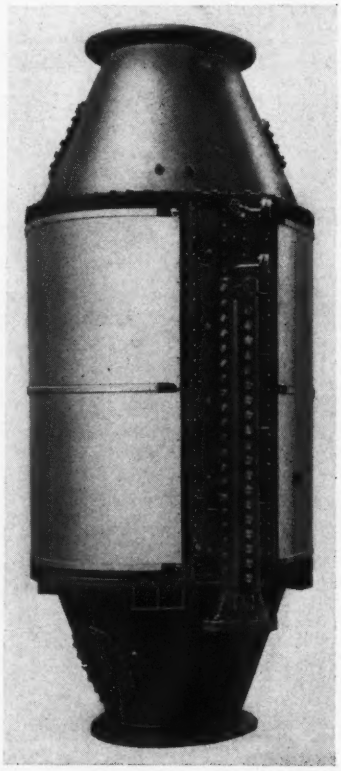
In operation, the entering circulating water passes through the openings in the screen plates and, in doing so, is broken up. The resultant agitation liberates the destructive air which rises up under the division plate and is carried off by the air ejector system. Since this system ends in the circulating water discharge pipe, the removal of the air is considerably aided by a partial vacuum caused by the rush of water past the end of the manifold. Thus entrained air is not permitted to reach the tubes or tube sheet in any harmful quantity and is in reality by-passed around the condenser. Its destructive force is spent on the material of the screen plates.



The presence of copper, steel and electrolyte, (in this case the circulating water) sets up a galvanic action in every condenser in varying degrees. The action is diverted from the condenser tubes to the metal screen plates with their many exposed surfaces, the screen plates being made of a metal higher in the electrolytic scale than that of the condenser tubes and tube sheet. Electrolysis therefore slowly destroys the plates but not the tubes or sheets.

La Mont Waste-Heat Steam Generator

COMBUSTION ENGINEERING Co., Inc., 200 Madison Ave., New York, N. Y., is now offering forced-circulation waste-heat boilers for both stationary and marine applications. In this type of unit the pump supplies seven to eight times, by weight, as much water to each tube as is converted into steam, and the coils of small tubing are arranged in parallel between an inlet and an outlet header. A nozzle at the entrance to each tube



insures adequacy of flow in the parallel circuits. In the waste heat unit shown herewith for utilizing the heat in Diesel engine exhaust, the tubes are spirally coiled, but the arrangement of heating surface and the location of the drum are flexible and can be adapted to any space conditions. Where an auxiliary boiler already exists it may be used as a receiver for the La Mont system and thus eliminate the necessity of a separate drum.

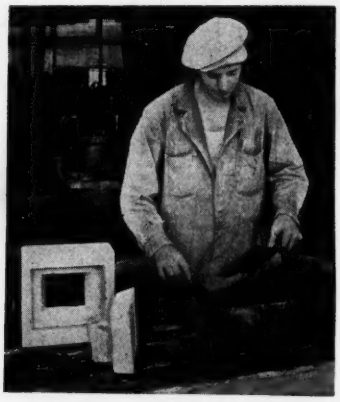
While such applications to Diesel engines usually employ exhaust gas temperatures of 500 to 800 deg. F. with steam generated at 50 to 180 lb. per sq. in., the boiler is also applicable to very much higher gas temperatures and steam pressures in stationary waste-heat installations.

Hydraulic Pump

A NEW motor-driven hydraulic pump capable of developing pressures up to 30,000 lb. per sq. in. (2000 atmospheres), also a dead weight gage (free piston gage) for measuring the pressures developed, are announced by the American Instrument Co., Silver Springs, Md. This pump is used for creating very high test pressures for determining strength of cylinders and spheres; for operating high-pressure and hydraulic intensifiers; and for carrying out experiments to determine the effect of extremely high pressures and sudden release on various materials.

Castable Refractory

AS A result of its recent development work on castable refractories, Johns-Manville, 22 E. 40th St., New York City, announces a new light weight Firecrete for making special refractory shapes, for replacing difficult brick construction, for lining furnace doors, and for making small monolithic linings. The new product's resistance to spalling is such that it will withstand direct ex-

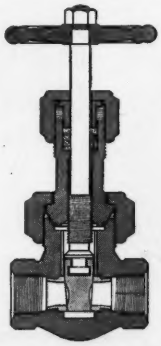


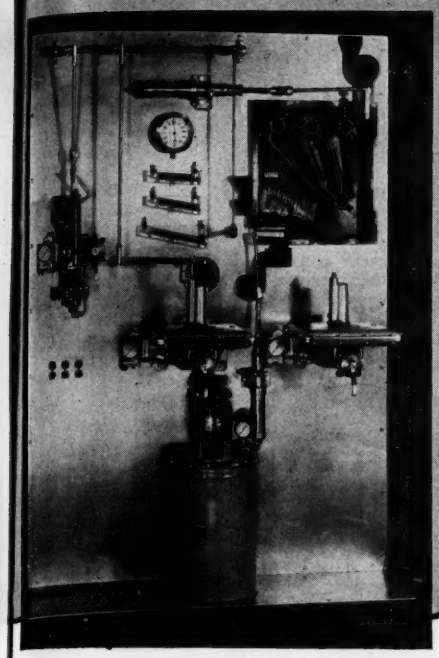
posure to flame temperatures, and is suitable for working temperatures up to 2200 deg. F.

Accepted laboratory and service tests have shown that this latest addition to J-M's line of Firecrete products possesses an exceptionally low heat storage capacity. This is of especial importance in intermittently operated furnaces, since appreciable quantities of heat are wasted in heating heavy fire brick and then allowing the furnace to cool. Sixty-five pounds if the material are required per cubic foot of finished construction.

Gate Meter Valves

RECENTLY placed on the market by Henry Vogt Machine Co., Inc., 10th & Ormsby Sts., Louisville, Ky., a new line of drop forged steel gate meter valves are of the union bonnet, ground joint, and inside screw stem type with removable rolled-in seats and a loose, slotted gate. They are made in the ¼, ⅜, ½, ¾ and 1 in. sizes of carbon steel with stainless steel trim or of all-stainless steel, as required by the particular operating conditions, valves of this type will be found suitable for many applications where safe and dependable regulation is required for meter and gage lines at high pressures and high temperatures.





Automatic Combustion Control need not cost you

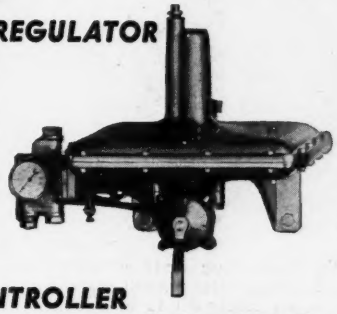
A LOT OF MONEY . . . . . .

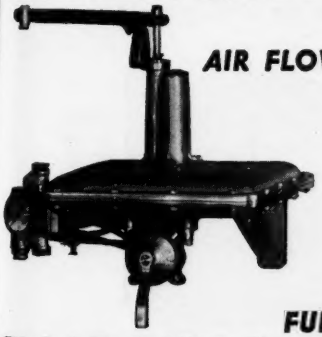
You can start by installing the Furnace Draft Controller alone . . . for as little as $98.00 if you want to

And begin to get its money-saving benefits right away. Since it works independently, you can add the rest of the system later.

FURNACE DRAFT REGULATOR

This Cash Standard Furnace Draft Regulator works from over-fire draft, regulating the boiler up-take damper, to maintain a constant draft in the combustion chamber. Place it near the up-take damper. It works independently of either of the two Controllers shown below. It does its part toward money saving by eliminating wasteful air infiltration.



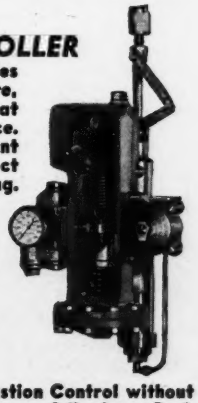


AIR FLOW CONTROLLER

This Cash Standard Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler doing its part to insure perfect combustion.

FUEL FEED CONTROLLER

This Cash Standard Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion; keeping the correct fuel-air ratio for perfect combustion — hence, money saving.



OIL CIRCULATOR

The purchase of this oil circulator is optional. The regulator and two controllers shown above can be properly operated by clean water, but it is preferable and cheapest in the long run to operate this equipment with this Cash Standard Oil Circulator, price $108 equipped with 110/220 v. 60 cy. motor.

Find out more about installing Automatic Combustion Control without great investment on your part — understand more fully how Cash Standard Control Systems work and what they will do to save money for you. Write for Bulletin 963-A-B.

Is the other part expensive?

Not at all! To make the system complete for one boiler you can get Fuel Feed Controller, Air Flow Controller with Operating Power Cylinders included (as in the Furnace Draft Regulator), and necessary connecting fittings, all for as little as $290.

And these are precisely the same control units that we furnish on the most elaborate kind of job, and for the largest kind of boilers. Of course, this money-saving plan is based on your installing the control units conveniently near the apparatus they operate, without panel board.

If, as an extra, you want the Hand Control Valves shown on each of the controllers in these cuts, they cost $30 each, installed on the controllers.

Of course, Cash Standard Control Systems come on panel boards if you want them; but they work just as well with the Control Units mounted individually elsewhere. The cut above shows a portable display panel on which full size Control Units (with miniature boiler) work automatically to show the real sensitivity, accuracy, and dependability of the Cash Standard System.

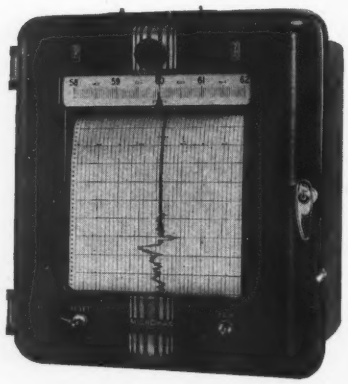
A. W. CASH COMPANY

Decatur, Illinois

CASH STANDARD CONTROLS .. VALVES

Micromax Frequency Controller

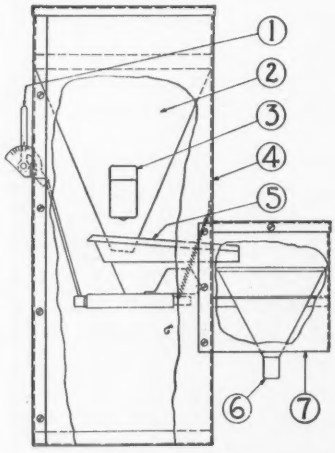
A NEW MICROMAX frequency controller—industrial type now provides the isolated generating plants with automatic control of frequency which heretofore has been thought feasible for large central stations on interconnected systems.



In one compact case is combined the well-known Micromax frequency indicator and recorder with an automatic controller, a simple, relatively inexpensive arrangement which omits the refinements necessary for large central stations on interconnected systems. Leeds and Northrup Co., 4934 Stenton Avenue, Phila., Pa.

Dry Chemical Feeder Machine

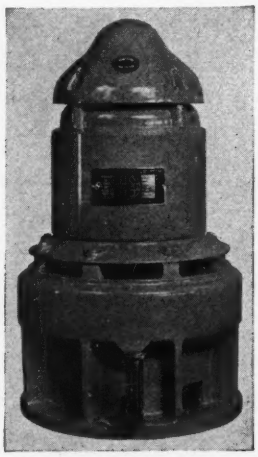
SYNTRON Co., 494 Lexington Ave., Homer City, Pa., has just placed on the market a new model of their vibratory type dry chemical feeder machine, designed for operation on ordinary 110 v., 60 cycle, single phase a.c. power supply. It is similar to their other models except that it is of smaller capacity. The machine is made up of a dust-type cabinet incorporating a 3 cu. ft. supply hopper



equipped with a noiseless electric vibrator to prevent any arching over and plugging in the hopper—with a vibratory feeder conveyor trough for discharging the material at the desired rate. The feeder trough discharges into an earthen ware, vortex type, solution pot contained in an extension cabinet enclosure so that the moisture around the solution pot will not affect the material in the main part of the machine itself. The top of the cabinet is designed so that the hopper can be sealed to an overhead chute coming down from the chemical room above.

Vertical Synchrogear

TO MEET the conditions peculiar to vertical operation U. S. Electrical Motors, Inc., Los Angeles, Cal., have developed a new vertical "Synchrogear." As shown by the illustration the unit is compact well balanced and presents a pleasing streamlined appearance. It comes com-

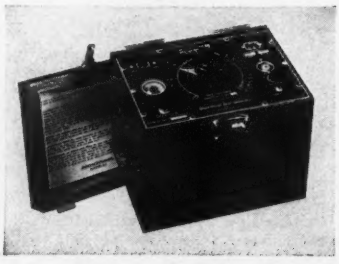


plete with flange base and is easily mounted. It incorporates a small geared oil pump which forces oil to bearings, gears, and pinion. Details can be obtained from either the Pacific plant of U. S. Electrical Motors, Inc., 200 E. Slanson Ave., Los Angeles, or the Atlantic plant at 80—34th St., Brooklyn, N. Y.

Megabridge

THE "MEGABRIDGE" is a new instrument developed by Industrial Instruments Inc., 162 West 23rd St., Bayonne, N. J., for making routine insulation tests, but which has the inherent accuracy of the Wheatstone bridge.

Electrically, the Megabridge is an adaptation of the Wheatstone bridge utilizing an electron ray null indicator. The electron tube replaces the delicate gal-



vanometer commonly used as a null detector. Operating from the a.c. power line, the megabridge has a self-contained d.c. supply for the bridge circuit and the electron ray tube.

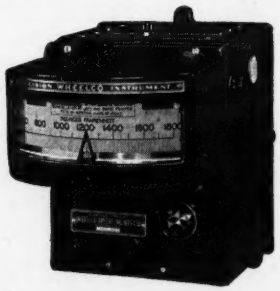
Housed in a walnut wood cabinet, 8 in. long, 7 in. high and 5¾ in. deep, the Megabridge weighs only 6¼ lb. It is available in a variety of resistance ranges and for different voltages and frequencies. The price ranges from $43.00 to $67.00.

Thermometer and Controller

RUGGEDLY constructed, this dial indicating thermometer, made by Wheelco Instruments Co., 1923-33 S. Halsted St., Chicago, Ill., is enclosed in a cast case with a 6-in. dial face, and large black on white numerals. It is available in

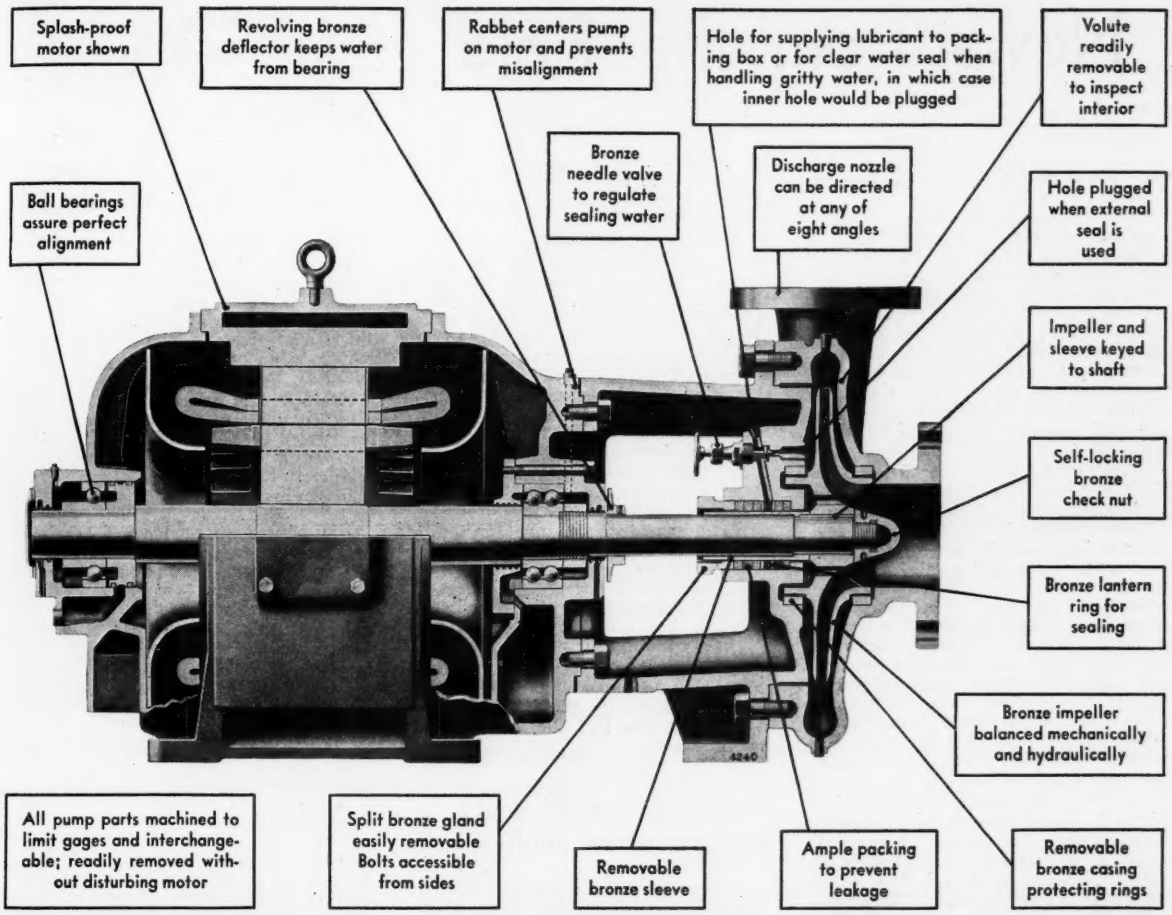
either long-distance or stem type in mercury, gas-filled or vapor actuations.

A product of the same company, this potentiometer controller is all electric in design and strictly non-mechanical. When instrument is in operation there is no motion except that of the galvanometer. Two small coils, part of the vacuum



tube oscillator system, are mounted at the zero point of the galvanometer. The galvanometer pointer carries a small flag, which passes between the two coils of the oscillator system and causes the inductance of the coils to drop sharply detuning the oscillator system. The plate current of the vacuum tube in a balanced circuit is decreased, allowing the relay to drop out effecting instantaneous control action.

UNIVERSAL MOTOR Co., Oshkosh, Wis., announces a complete new line of Diesel electric light and power plants. The single cylinder models are being offered in 3000 and 5000 watt sizes, both a.c. and d.c. The four cylinder models range from 5000 watts up both a.c. and d.c. Both single cylinder and four cylinder models of the full Diesel compression ignition type are being offered. Soft combustion low compression and pressure are featured in the four cylinder models. Single cylinder models feature the Bosch fuel ignition system and Bosch acro combustion chamber above the piston. Both engines have removable cylinder liners.


Splash-proof motor shown
Revolving bronze deflector keeps water from bearing
Rabbet centers pump on motor and prevents misalignment
Hole for supplying lubricant to packing box or for clear water seal when handling gritty water, in which case inner hole would be plugged
Volute readily removable to inspect interior
Bronze needle valve to regulate sealing water
Discharge nozzle can be directed at any of eight angles
Ball bearings assure perfect alignment
Hole plugged when external seal is used
Impeller and sleeve keyed to shaft
Self-locking bronze check nut
Bronze lantern ring for sealing
Bronze impeller balanced mechanically and hydraulically
All pump parts machined to limit gages and interchangeable; readily removed without disturbing motor
Split bronze gland easily removable Bolts accessible from sides
Removable bronze sleeve
Ample packing to prevent leakage
Removable bronze casing protecting rings

DE LAVAL MOTOR MOUNTED PUMPS

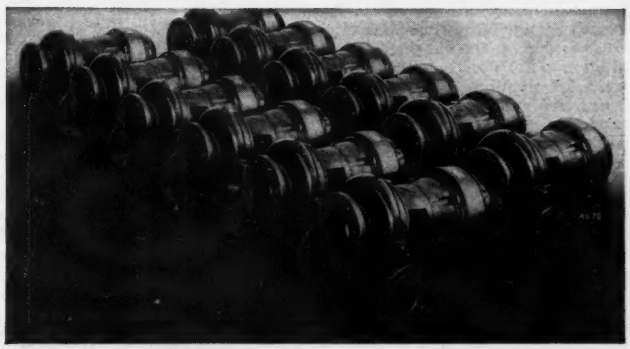
are first quality pumps built by mass production methods.

All parts subject to wear are finished to limit gages and are interchangeable.

The pump is mounted directly upon the frame of an electric motor of any desired type, and the unit can be supported in any position and wherever most convenient.

Available in capacities up to 1200 gal. per min., against heads up to 230 ft.

Write for Catalog BF-100, containing pump rating and pipe friction tables and instructions for selection and installation.



• Part of an order for 50 De Laval Motor-Mounted Pumps; 250 gal. per min., each, against 16 ft. head.

DE LAVAL *Steam Turbine Co.*
TRENTON, N. J.

MANUFACTURERS OF STEAM TURBINES, PUMPS — CENTRIFUGAL, PROPELLER, ROTARY DISPLACEMENT, CENTRIFUGAL BLOWERS AND COMPRESSORS, WORM GEARS, HELICAL GEARS, HYDRAULIC TURBINES AND FLEXIBLE COUPLINGS • • • SOLE LICENSEE OF THE BAUER WACH EXHAUST TURBINE SYSTEM

News from the Field

IT WAS announced by Max Babb, president of the Allis-Chalmers Mfg. Co., that on May 5 at a directors' meeting Walter Geist was appointed Vice President of the Company.

Mr. Geist entered the employ of Allis-Chalmers in 1909 as an errand boy and from that position he advanced by progressive steps from which he derived a broad knowledge and experience of the various products of the Company. He originated the idea of the multiple V-belt drive principle of power transmission, known as the Texrope Drive. He first developed this from the engineering point of view and later as a sales engineer; and was made assistant manager of the Milling Department in 1928.

THE BUELL ENGINEERING CO., of New York, and the B. F. Sturtevant Co., of Hyde Park, Boston, have completed arrangements whereby the Sturtevant field organization, operating out of the forty Sturtevant offices, will parallel the work of the Buell service staff. By such coordination, the two organizations will bring Buell dust and fly ash collection service closer to interested companies, and since Buell and Sturtevant products are complementary, the new arrangement enables the engineer to secure at one time, from a single source, both the dust or fly ash equipment and the fan equipment as a complete system with no division of responsibility.

R. W. EICHENBERGER, Vice President of the Robins Conveying Belt Company, formerly acting as Manager of their Chicago Office, has been transferred to the New York Office at 15 Park Row, where he will collaborate in general sales management for the company with H. Von Thaden, Vice President.

ON April 26, Benjamin F. Fairless, president of the United States Steel corporation of Delaware announced that G. Cook Kimball has been elected an executive vice president, with headquarters at its Chicago executive offices recently established at 208 South LaSalle St. The formal announcement of this new activity was made at a luncheon given by Mr. Fairless, at the Blackstone hotel. In addition to Mr. Fairless, others who spoke are E. R. Stettinius, Jr., chairman of the board, and E. M. Voorhees, chairman of the finance committee both of the parent corporation, and Mr. Kimball. Mr. Kimball is well known in Chicago where for many years as an official of the Illinois Steel Company and the Carnegie-Illinois Steel Corporation, United States Steel Subsidiaries, he has maintained his executive offices and where, for the past four years, he has been executive vice president of the Carnegie-Illinois Steel Corporation. He has been connected with United States Steel Subsidiaries since 1901, beginning in the engineering department of the American Tin Plate Company a year after his graduation from Harvard University. From 1905 to 1931 he served as chief engineer of the American Sheet and Tin Plate Company and in 1931 was elected vice president and a director of the company. Mr. Kimball is a director of Carnegie-Illinois Steel Corporation, president of Illinois Steel Company, president of Gary Land Company, and a director of Illinois Manufacturers Association.

THE NATIONAL ALUMINATE CORP. announces the transfer of R. S. Wise from Chicago area to the South Central States with headquarters at Knoxville, Tenn. T. G. Cocks formerly at Knoxville has been moved to Chicago. R. P. Clausen has been appointed Junior Engineer in the Philadelphia territory.

A. J. WADHAMS, Vice-President of the International Nickel Co., Inc., and manager of the Development and Research Division, has announced the establishment of a new field office located at 67 Wall Street, New York, N. Y., which was opened May 1, and is under the direction of J. W. Sands. The territory covered includes Metropolitan New York, Long Island, New Jersey; Pennsylvania, east of Williamsport, Harrisburg, York; Delaware, Maryland, Virginia, and the District of Columbia.

R. B. MILDON, Vice-President of the Westinghouse Electric & Mfg. Co., formerly in charge of the East Pittsburgh Division, has moved to Pittsburgh headquarters of the company to assume special sales assignments. A. C. Streamer, formerly manager of the Switchgear Division, has been appointed General Manager of the East Pittsburgh division.

CHARLES E. SPENCER, JR., President of the First National Bank of Boston, has been elected to the Board of Directors of Arthur D. Little, Inc., of Cambridge, Mass.

Northwestern University Institute of Technology

FOLLOWING this first announcement, on March 21, by Walter Dill Scott, President of Northwestern University, that the trustees had approved the establishment of a new Institute of Technology and that this will be operated on a cooperative basis under which students will spend alternate periods in school and in carefully selected cooperating industries, many of the details of this undertaking have since been made public.

This Institute which was made possible by the offer of the Walter P. Murphy Foundation to build and equip the unit, the total cost of which will approximate $6,500,000, will be located on the Evanston, Ill., campus and will provide for a total of approximately 800 students in the four departments of civil, mechanical, electrical and chemical engineering. Construction work will be started immediately and the building will house the Institute as well as the University's present physics and chemistry departments.

Ovid W. Eshbach, personnel official in the New York office of the American Telephone & Telegraph Co., has been appointed dean of the Institute. He has had practical experience in administering cooperative courses and will take up his new duties immediately. As educational consultant, he will have the services of Robert C. Disque, Dean of the School of Engineering of Drexel Institute of Technology, Philadelphia. Mr. Disque assumes the position left vacant by the recent death of Dean Herman Schneider of the University of Cincinnati, founder of the cooperative plan.

This new Institute will be closely integrated with the rest of the University from which it will gain great strength.

C. F. Hirshfeld

DR. C. F. HIRSHFELD, internationally known educator and engineer, Chief of Research of The Detroit Edison Company, died at Grace Hospital, Detroit, Mich., April 19, 1939, after an illness of several months. He is survived by his wife, two sons, and a granddaughter. Dr. Hirshfeld was distinguished in numerous fields, his work including: consulting practice in several branches of engineering and research; World War service with the rank of Lt. Colonel in the U. S. Ordnance Department; the writing of many books and papers on engineering subjects; and in recent years the development of the P.C.C. street car, a revolutionary advance in the field of urban transportation.

Born in San Francisco, Cal., on January 30, 1881, he graduated from the University of California in 1902, with the degree of Bachelor of Science in Electrical Engineering. In 1903 he became an instructor at Cornell University and in 1905 received the degree of Master of Mechanical Engineering from the institution. He remained a member of the faculty until 1913, advancing to the position of Professor of Mechanical Engineering. During this period he was author and co-author of several text books on steam power and internal combustion engines which are still classics in their field. In addition to his academic duties, he carried on an extensive consulting practice.

In 1913 he became associated with The Detroit Edison Co. as Chief of Research, a position held until his death. The association provided for the continuance of his practice as a private consultant. Under this arrangement, he served as chief engineer in the development of a modernized street car, embodying revolutionary changes in truck and wheel construction, lighting, ventilation, control, body design, etc.

In addition to these manifold professional interests, Dr. Hirshfeld has devoted much attention to activities of various scientific and engineering organizations both here and in Europe, over a period of years. From 1928 until 1938 he was Chairman of the A. S. M. E. Committee on the Economic Status of the Engineer and was instrumental in the establishment of the Engineers' Council for Professional Development.

His published contributions on engineering and economic subjects are numerous. Various honors have been conferred upon Dr. Hirshfeld in recognition of his accomplishments. In 1932 Rensselaer Polytechnic Institute conferred the honorary degree of Doctor of Engineering upon him; in 1934 he was awarded the A. I. E. E. national prize for his paper on public relations and education, "Engineers of the Next Generation"; and he was the recipient of the Worcester Reed Warner Medal from the A. S. of M. E. in 1937. In June, 1938, he was awarded the honorary degree of Doctor of Engineering by the University of Detroit.

Dr. Hirshfeld's outstanding achievement was his ability to apply research methods to any type of problem. He was president of the Utilities Coordinated Research, Inc., formed by a group of electric utility companies—whose purpose is to coordinate research of various operating companies, and to provide group research studies of a very wide and general interest to the sponsors. He was also a great humanitarian and lover of

How to REDUCE COSTS *in* YOUR PLANT

Westinghouse Stoker installation in plant of Bemis Bros. Bag Company, Brooklyn, N. Y. Single Retort Moving Grate Stokers firing two 257-HP boilers.

This manufacturer saves 15% on fuel cost, plus $400 a year maintenance expense, with Westinghouse Single Retort Stokers

That's a real saving—worth-while for any manufacturer. In addition, the Westinghouse Single Retort Moving Grate Stokers have eliminated a neighborhood smoke nuisance.

The Bemis Bros. Bag Company of Brooklyn, owners of this plant, estimate that the two new stokers, replacing former equipment, will return their entire cost, in the form of actual savings, within four years.

• • •

Let us survey your plant . . . perhaps you can save important money . . . No cost or obligation is involved in having a Westinghouse Stoker engineer make a study of your plant. Often savings like the above result, and frequently lower cost fuels may be used with *increased* efficiency. Ask any Westinghouse Sales Office for this service.

The Westinghouse Stoker Line is Complete

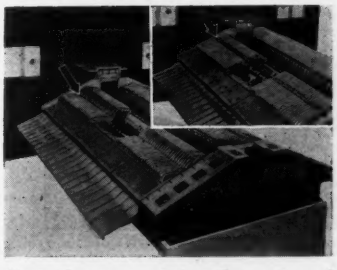
Multiple Retort Stokers for Boilers rated 300 BHP up
Single Retort Stokers for Boilers from 100 to 500 BHP

Send for this Book. A new book, B-2170, tells you all about these stokers. Send for your copy. Address Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa. Dept. 7-N.

I-80218-A

Such savings are possible because Westinghouse Moving Grate Stokers provide effective coal distribution, promote smokeless combustion, are flexible in the amount and kind of fuels they handle, and have exceptionally long life. The thorough agitation of the fuel bed permits adequate air flow for efficient combustion and keeps grates cool and cuts maintenance costs.

HOW MOVING GRATE STOKERS DO THEIR WORK



Arrows indicate the same point on the grate surface at the two extreme positions of the grates. With a continuous wave-like motion, the grates keep the fuel bed constantly agitated, securing thorough penetration of air. Clinker formation is therefore minimized.

Westinghouse Stokers

WESTINGHOUSE ELECTRIC

C. F. Hirshfeld

men with a particular and intense interest in the welfare of young men with whom he always closely associated himself and who often sought his counsel.

M. W. Smith Elected V. P. of Westinghouse

MARVIN W. SMITH, Manager of Engineering of the Westinghouse Electric & Mfg. Co. has been elected a Vice-President of the company by the Board of Directors on April 26, 1939. Mr. Smith, who will direct all the company's engineering activities, has been associated with Westinghouse since the day he left college in 1915.

Coming to Westinghouse as a student engineer, Mr. Smith did shop and office work, then moved steadily upward. He

M. W. Smith

has been Manager of Engineering since May 7, 1936, during which time the company has produced several major new developments in engineering.

Born at Overton, Texas, October 8, 1893, Mr. Smith attended high school in that city and was graduated from Texas Agricultural and Mechanical College in 1915 as valedictorian and with a degree of bachelor of science in electrical engineering. At completion of his student course, the young engineer was selected by the late B. G. Lamme, then chief engineer of Westinghouse, to work for six months in his office, studying special design problems.

In 1917, Mr. Smith was assigned to the Power Engineering Department becoming section engineer in 1927, and division engineer in 1930, which position he held until 1936 when he was appointed manager of engineering. His headquarters are in Pittsburgh, Pa.

Frank A. Banks Succeeds the Late J. D. Ross

FRANK A. BANKS, construction engineer of the Grand Coulee Dam project, has been appointed as Acting Administrator of the Bonneville Project to succeed the late John Delmadge Ross. Mr. Banks, 57 years old, is a graduate of the University of Maine in civil engineering and has been employed continuously by the Bureau of Reclamation since 1906. He worked up through the field service

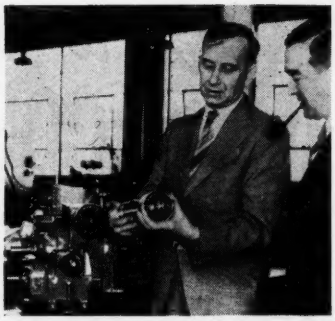
Frank A. Banks

of the Bureau to the position in 1917 of construction engineer of American Falls Dam in Idaho, and in 1920 went to the Owyhee Project in Oregon as construction engineer of the great Owyhee Dam, then the outstanding engineering structure in the world. In August, 1933, when the Grand Coulee Dam Project was begun Frank Banks was assigned to the job as construction engineer and he has supervised the work since that date. While Acting Administrator of the Bonneville Project Mr. Banks will continue as construction engineer of Grand Coulee Dam.

Variable Speed Transmission

BRIGGS & STRATTON CORP., Milwaukee, Wis., have become exclusive licensees for the manufacture and sale of the Graham unit, now to be called the Briggs & Stratton Variable Speed Transmission. Several new sizes are being added. The complete line will cover units from ⅛ to 10 hp. as well as a complete line of controls. Briggs & Stratton Corp. has been manufacturing the Graham variable speed transmission for a year and a half for Graham Transmissions, Inc.

This transmission, described on page 604 of the September, 1938, issue of



POWER PLANT ENGINEERING, gives speeds in infinite steps from maximum to zero and reverse, is self-contained, runs in oil, is all metal in construction, permits change in speed both running and stationary, and develops full torque over the entire range of speed down to zero.

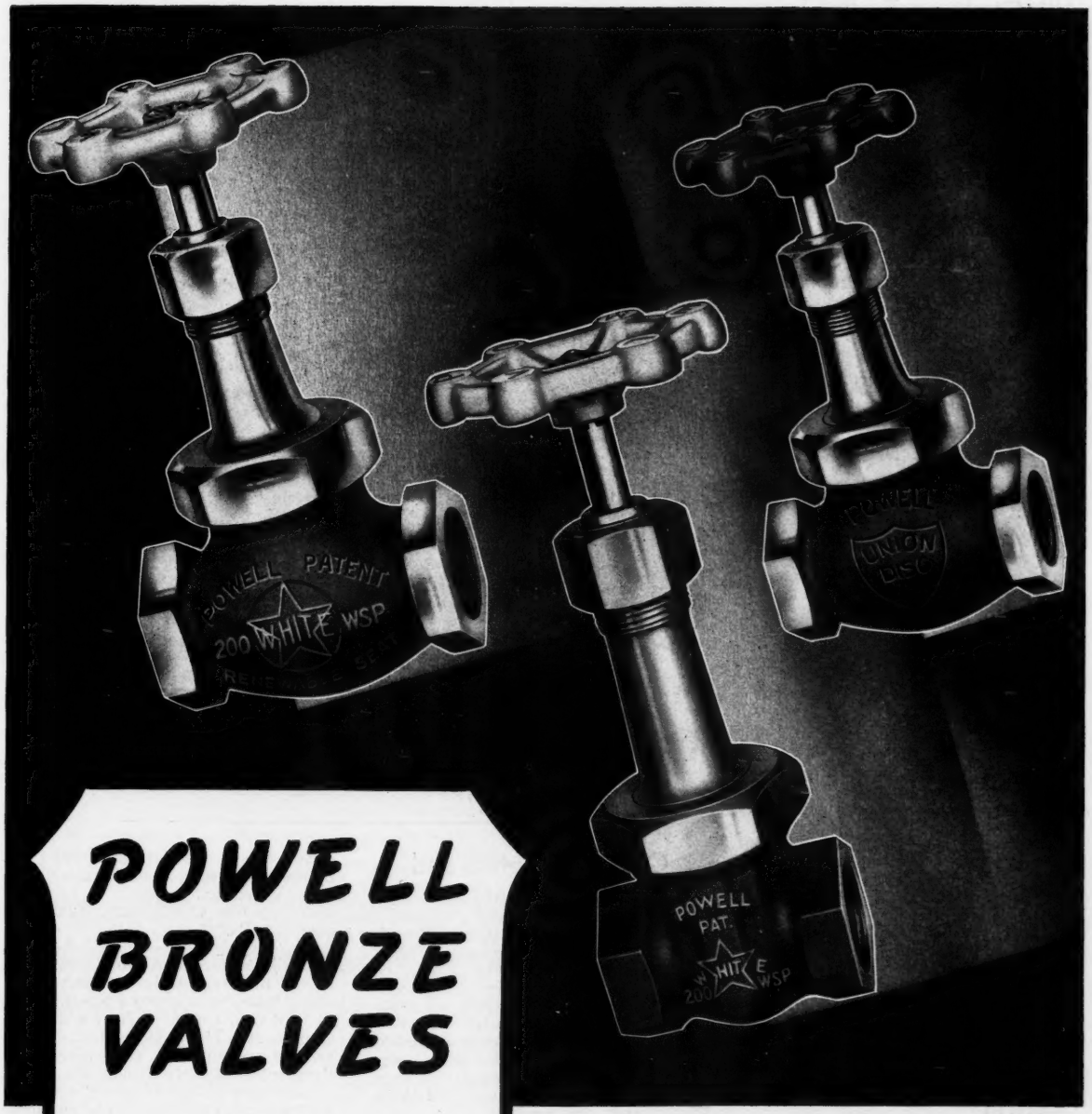
L. A. Graham and A. Madle, formerly vice president and chief engineer, respectively, of Graham Transmissions, Inc., have joined the Briggs & Stratton organization and will continue to be actively associated with the design and sale of the device.

P. A. Condit Joins Cooper-Bessemer

PAUL A. CONDIT recently joined The Cooper-Bessemer Corp. in the capacity of Control Engineer. He will make his headquarters at Mt. Vernon, Ohio, and will effect a close liaison between the sales and engineering department in industrial control problems, particularly in coordinating Cooper-Bessemer gas and Diesel engines with modern manufacturing processes. Mr. Condit, an electrical

Paul A. Condit

engineer, was born near Columbus, Ohio, in 1906 and attended Denison, Ohio Northern and Cincinnati Universities. He has had a wide experience which includes railroad control and signal work, electrical control work in refineries and as development engineer for the Mason-Neilan Regulator Co. Mr. Condit is a member of the A.I.E.E. and a Professional Electrical Engineer.



POWELL BRONZE VALVES

Do a Better Job for a longer time!

POWELL BRONZE VALVES ARE CAST PRINCIPALLY FROM VIRGIN METALS WITH A HIGH TIN CONTENT TO IMPROVE THE PHYSICAL CHARACTERISTICS.

POWELL BRONZE VALVES ARE FUNDAMENTALLY CORRECT IN DESIGN TO WITHSTAND THE MOST EXACTING OPERATING CONDITIONS.

POWELL BRONZE VALVES ARE MADE TO GIVE SATISFACTION—TO DO A BETTER JOB FOR A LONGER TIME!

POWELL VALVES

THE WM. POWELL CO. CINCINNATI, OHIO

Allis-Chalmers To Build New Pittsburgh Plant

CONTRACTS have been let to build a new transformer plant in Pittsburgh, to be known as the River Plant of the Allis-Chalmers Mfg. Co., Pittsburgh Works. The plant will be 416 by 144 ft.; will cost, with buildings and equipment, about $378,000; and will be put into operation about August 15.

In design, this plant will represent the latest manufacturing methods as applied to the production of distribution transformers. It will be set up on a line production basis—raw material coming in at one end and a finished product going out at the other—and it will generally increase efficiency as applied to production of this product. The general contractor awarded this job is H. M. Siesel Construction Co., of Milwaukee and Pittsburgh. Contracts for the steel work go to the Bethlehem Steel Corp.

Diesels for Clinton

ORDERS were recently placed for two Diesel engine generating units to be installed in the new municipal power plant being erected for the Village of Clinton, Mich., with PWA aid. The two units will consist of seven-cylinder Type LT Cooper-Bessemer Diesels, rated 730 hp. at 257 r.p.m., and driving Ideal 630 kv-a. generators with V-belted, 15 kw. exciters. Engineers, Fargo Eng. Co., of Jackson, Mich.

Smoke Prevention Association

THE THIRTY THIRD Annual Convention of the Smoke Prevention Association will be held at the Hotel Schroeder in Milwaukee, Wis., on June 13 to 16.

All phases of the smoke problem will be presented and an educational program has been arranged in which methods and modern practices involved in smoke and air pollution control will be shown. An exhibit of fuel burning equipment and smoke prevention apparatus will be on display. Participating in this exhibit and contributors to the material displayed will be the United States Bureau of Mines; the Battelle Memorial Research Institute of Columbus, Ohio; the Stoker Manufacturers Association; the Railroad General Managers Association and the Works Progress Administration Air Pollution Survey now being conducted in Chicago, Ill.

Another Million Pounds for Ford

HENRY FORD, who was chief engineer of the Detroit Edison Co., while he was building his experimental automobiles, 40 yr. ago, has always maintained his interest in the power plant and on April 13 turned the control on a new boiler, No. 7, in the No. 1 powerhouse of the Ford Motor Company's River Rouge plant. This boiler will supply steam to a new 110,000 kw. turbogenerator scheduled for completion in May.

This new section of the plant will parallel and practically duplicate the two sections which are now in use. Total cost of the powerhouse enlargement is around $3,500,000.

Like No. 3, the new Generator No. 4, will be a steeple or vertical compound unit rated at 110,000 kw., made up of two 55,000 kw., 1800 r.p.m. elements, generating 3 ph., 60 cycle current at 13,800 v. Throttle conditions are 1215 lb., 925 deg. F. and the unit is arranged for four stages of bleeding at 225, 86, 25 and 7.4 lb. absolute. The water rate of 90,000 kw. is equal to 8.05 lb. per kw-hr. equivalent to 8879 B.t.u., or a thermal efficiency of 38.5 per cent.

The condenser is of the single pass type with a surface of 73,000 sq. ft., made up of 11,388 7/8 in. O.D. tubes, 28 ft., 3 1/8 in. long. Circulating water is provided by two 54 in., 58,700 g.p.m. at 18.42 ft. head, 300 r.p.m. pumps. Two 10 in., 2000 g.p.m. at 200 ft. head, 900 r.p.m. hotwell pumps are installed.

The boiler, characterized as the largest high pressure unit in the world, has a capacity of 900,000 lb. of steam per hr. at 1400 lb., 925 deg. F. The total heating surface of 169,145 sq. ft. is made up as follows: Boiler proper 24,410; water walls 9500; superheater 24,019; economizer 25,200; air heater 86,016. The furnace measures 25 ft. 8 in. by 32 ft., a total height of 35 ft. and a volume of 29,000 cu. ft. The boiler is of the double bent tube type with one 40 in. I.D. dry drum, two upper 48 in. I.D. drums and two 40 in. I.D. lower drums.

Fuel used will consist of a combination of pulverized coal, blast furnace gas and coke oven gas. Four coke oven gas burners with a total capacity of 300,000 c.f.m. can generate up to 120,000 lb. of steam per hr. Four blast furnace gas burners with a total capacity of 1,800,000 cu. ft. can generate up to 110,000 lb. of steam per hr. Twelve coal feeders are arranged for corner or tangential firing and can each handle 3¾ t. of coal per hr. The total fuel consumption at full load equals 46 t. per hr. The unit has two 260,000 c.f.m. induced draft fans, four 70,000 lb. per hr. forced draft fans and two 50,000 c.f.m. primary draft fans.

Boiler feedwater will be pumped by two 2800 g.p.m., 2300 ft. head boiler feed pumps driven by 1775/1525 r.p.m. motors and two 2535 g.p.m., 1771 ft. head booster pumps. The 2430 sq. ft. high pressure heater will have a capacity of 840,000 lb. per hr. heated from 310 to 395 deg. F. The cross over heater with the same capacity and surface will heat water from 240 to 311 deg. F. The deaerating water will heat from 171 to 240 deg. F., guaranteed to deliver 1,283,200 lb. per hr., with a maximum oxygen content of 0.03 cc per liter. The low pressure heater with an area of 3000 sq. ft. will heat 688,000 lb. of water per hr. from 87 to 171 deg. F.

For the Engineer's Library

Recent bulletins and catalogs on power plant equipment listed for your convenience in securing specific information. Power Plant Engineering will be glad to procure for you any free literature that you desire.

Controls, Meters and Instruments

Conductivity Meters—General application of conductivity measurements for determining the purity of distilled water or condensate, including condenser leakage, is described in mimeographed bulletin RC-121. A new model continuous checker is described in detail in bulletin DW-100. Copies of both bulletins are available from Industrial Instruments, Inc., 162 West 23rd Street, Bayonne, N. J.

Instruments—In a 110-page booklet, report is made of an investigation of sales of instruments, their principles, uses and the distribution of use for various purposes and industries. Period covered is 1923 to 1935. Economic gain from the use of instruments is discussed. Issued as Report No. M-1 of National Research Project, W.P.A., 1734 New York Ave., N.W., Washington, D. C.

If the Wind Wrecked Your Power Plant is the title of a new bulletin which illustrates and describes Hays Dry Type Draft Gages. The Hays Corp., Michigan City, Ind.

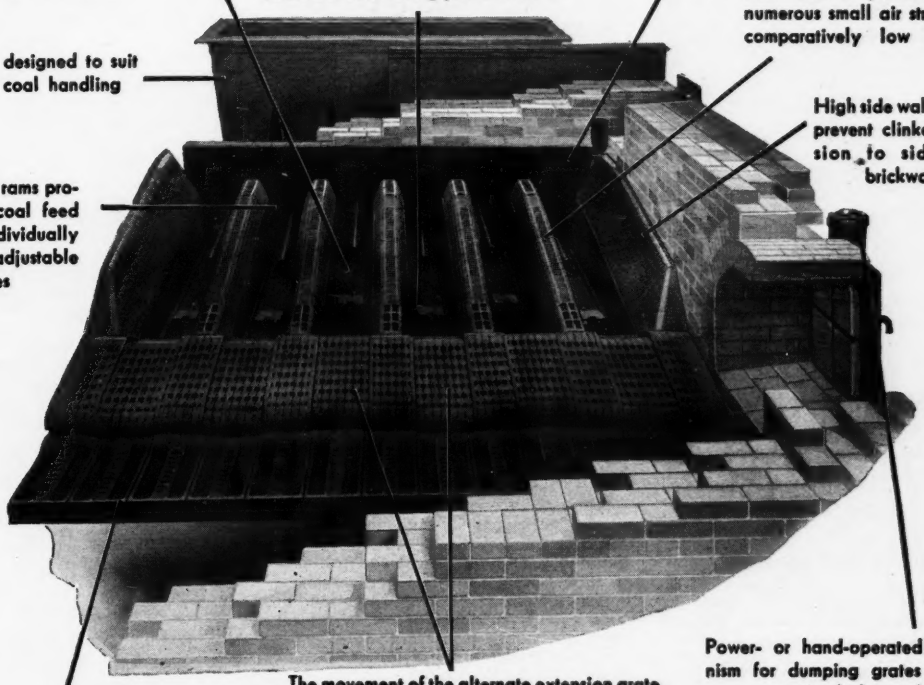
Combustion Control—The application of Metermax combustion control to boiler furnaces of every major type—pulverized coal fired, stoker fired, gas and oil fired—is featured in a new 32-page catalog, N-01-163. Profusely illustrated this publication not only pictures each type of installation, but by means of schematic diagrams shows how Metermax is applied. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa.

Indicator—A new catalog describes briefly the separate instruments which when taken as a group from the complete R.C.A. Engine-Indicator diagram equipment. The instruments covered are the pressure unit, the oscillograph, the amplifier and the synchronizer. The catalog also gives the specifications of the equipment and touches briefly upon its uses and its applications in work with pressure diagrams. Engineering Products Div., R.C.A. Mfg. Co., Inc., Camden, N. J.

Premax Indicator—Bulletin 278 entitled Maintaining Diesel Dependability illustrates and describes the applications of the Premax Indicator to determine accurately the compression and firing pressures in the engine. Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.

Motor—A new bulletin, 251-A, describes an alternating-current, adjustable speed, Polyspeed motor. New information not given in the previous bulletin includes a description of the various types of regulators available for manual, remote or automatic speed control. A number of installations are illustrated and described. Crocker-Wheeler Electric Mfg. Co., Ampere, N. J.

Reasons for the Outstanding Performance


Large, spacious retorts and complete underfeed action insure slow distillation of gases
Correct fuel distribution under full mechanical control is secured with inclined fuel bed and individually adjustable moving retort bottoms having pusher blocks
Front wall wind boxes protect the front wall brickwork against erosion
Fuel bed is penetrated by numerous small air streams at comparatively low pressure
Coal hopper designed to suit method of coal handling
High side wall tuyeres prevent clinker adhesion to side wall brickwork
Large square rams provide ample coal feed and have individually and easily adjustable strokes
Power- or hand-operated mechanism for dumping grates is conveniently located
Air at low pressure is admitted under dumping grates to burn out the combustible before refuse is dumped
The movement of the alternate extension grate sections is coordinated with that of the moving retort bottoms. Air control is provided to the extension grates

Detroit Multiple Retort Stoker . . . . . .

● **RESULTS . . . USERS SAY THIS —**

"Over 80% average efficiency—an every day experience."

●

"We have operated your stoker almost continuously for three years; don't believe our repair bills would total $75.00."

●

"Results obtained very satisfactory and its efficiency certainly is far better than the equipment that it replaced."

●

"We carry 200% rating with Illinois screenings very satisfactorily."

●

"Saved 362 tons of coal the first three months of operation."

●

"Economy of coal, instantaneous response to sudden demands are reasons for repeat orders."

●

"It handles our light load periods satisfactorily."

●

"We estimate our savings last year at $2500."

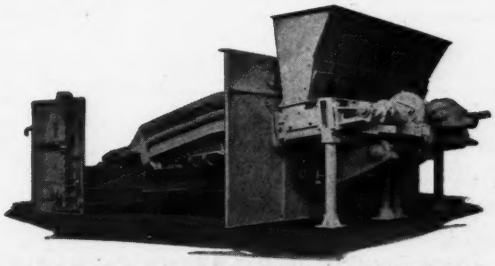
"Our last three Stoker purchases are Detroit—very satisfactory—continuous service—250% of rating."

●

"Our daily efficiencies run from 78% to 80%."

●

Get the whole Multiple Retort story. Write for Bulletin 124.



Detroit Multiple Retort Stoker An inclined fuel bed Stoker with many outstanding features of design.

DETROIT STOKER COMPANY

FIFTH FLOOR, GENERAL MOTORS BUILDING • DETROIT, MICHIGAN

Works at Monroe, Mich. . . . District Offices in Principal Cities . . . Built in Canada at London, Ontario

Dan River Cotton Mills install Ring-Tie Distribution System is the title of Bulletin 3901 which is descriptive of a recent switch-gear installation in a large cotton mill in southern Virginia. I-T-E Circuit Breaker Co., Philadelphia, Pa.

Control Apparatus, Rheostats and Resistors are illustrated and described in a new catalog which shows a variety of motor control apparatus, battery charging equipment. Prices and dimensions of equipment are included in the catalog. Schaefer Bros. Co., 1059 West Eleventh St., Chicago, Ill.

Outdoor Oil Circuit Breakers for framework or pole mounting, manually or electrically operated, are described in a new booklet, Descriptive Data 33-745. The breakers are multi-tank; one, two three or four pole, single throw. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Pictorial Index — A convenient, quick reference, illustrated index for use with the company's 168-page bulletin 38-D listing a very complete line of bus and cable connectors is being distributed by The Delta-Star Electric Co., Chicago, Ill.

Metal-Clad Switchgear—Catalog 8-a is a comprehensive and profusely illustrated catalog on this type of switchgear. The Roller-Smith Company, Bethlehem, Pa.

Small-capacity Switchboard Panels for the control of generators and feeder used for general power and lighting service in small direct-current plants are described in a new booklet, descriptive data 31-132. The maximum generator ratings covered are 75 kw., 125 v., or 150 kw. at 250 v., with a maximum feeder rating of 600 amp. The generator panels are for either parallel or non-parallel operation with self-excited generators, in live-front or dead-front construction. Separate diagrams and data are given for each type of panel and assembly. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Metals

Design of Switchhouses for generating stations and Transmission substations. A report of the Apparatus and Design Division of the Electrical Apparatus Committee of the Edison Electric Institute. This report presents information of the basic design of switchhouses operating at voltages between 11 kv. and 24 kv. It includes reports on specific projects of 11 operating companies, covering 12 generating stations and 1 transmission substation. In addition, comments of a general nature from 5 other companies are included. The report is designated Publication No. F5. The price is 40c to members and their employees, $1.00 to non-members in the U. S. A. and $1.10 to foreign countries. Copies may be obtained from the Edison Electric Institute, 420 Lexington Ave., New York, N. Y.

Metals—This edition of Bulletin T-13, entitled Nickel and Nickel-Base Alloys, Their Use in the Design of Corrosion-Resistant Machinery and Equipment, carries many changes from the preceding one. The text has been enlarged and, for some sections, rewritten extensively, and the tables and curves revised to include the latest available information. The International Nickel Co., Inc., 67 Wall St., New York, N. Y.

Alloy Tubes — Technical Bulletin No. 12, Condensed Technical Data on High-Temperature Steels, containing very useful information and technical data on B & W seamless alloy tubes and pipe for high pressure and high temperature services. Curves and a complete tabulation are given. The bulletin may be had by making request on company letterhead or by otherwise giving company connection. The Babcock & Wilcox Tube Company, Beaver Falls, Pa.

Metal—A new 20-page publication containing information on copper and brass pipe and tubing has just been issued by Revere Copper & Brass, Inc., 230 Park Ave., New York, N. Y.

Welding of Wrought Iron is the title of a revised bulletin issued by A. M. Byers Co. Tests have since been run by the National Weld Test Bureau, Lloyd's Register of Shipping, American Bureau of Shipping, and the Bureau of Marine Inspection and Navigation. In addition, considerable practical information has been obtained from the field.

Inco—The current issue of a magazine on uses of nickel and nickel alloys describes nickel lining for a freight steamboat, alloys for heat control, uses of nickel alloys for anchors, spoons, moving electric signs, protection of piles against marine borers, safety razors, air compressors and dial indicators.—International Nickel Co., 67 Wall St., New York city.

Mechanical Power Transmission

Speed Reducers—Bulletin 7838, fully illustrated, gives complete engineering information on Saco speed reducers. The bulletin discusses four different machines with capacities ranging from 1000 to 5000 lb. Stephens-Adamson Mfg. Co., Aurora, Ill.

Pulleys—Catalog No. 40 consists of 12 pages of general engineering information on Lewellen Variable Speed Motor Pulleys. Rating tables for the different sizes are included in the bulletin. Lewellen Mfg. Co., Columbus, Ind.

Vari-Pitch Sheave—A new bulletin (No. 1261-B) on Vari-Pitch Texrope Sheaves illustrates and describes the stationary control type for occasional changes of speed and the motion control type for use where frequent speed changes are necessary. It includes dimension sheets and a variety of installation photographs. Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Traction Type Hydraulic Coupling—is completely illustrated and described in a new 8-page bulletin which was recently issued by the Hydraulic Coupling Division of American Blower Corp.

Flexible Couplings — L-R Flexible Couplings are illustrated and described in a new bulletin including a full page capacity table in horsepower. Lovejoy Flexible Coupling Co., 5009 W. Lake St., Chicago, Ill.

Roller Bearing Flexible Drive Shafts is the title of a new 12-page industrial catalog Ind. 1939 illustrating and describing the subject giving construction features and application. Two pages of general engineering data are included. Mechanics Universal Joint Div. of Borg-Warner Corp., Rockford, Ill.

Pumps and Compressors

Compressor—Bulletin 3426-1, supplements Bulletin 3426 which describes in detail PRE Compressors in sizes up to 500 hp. This supplement describes the distinctive features such as force-feed lubrication, turret-type channel valves and four corner construction which are incorporated in PRE Compressors in sizes for 600 to 3000 hp. Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

Boiler Feed Pumps—Full information on Pacific's multistage, double case, forged steel pumps, together with various new design features is explained in detail in a new 24-page bulletin. Pacific's line of hot oil pumps offers a variety of pumps handling temperatures up to 850 deg. F. and differential pressures up to 25 lb. Pacific Pump Works, 5716 Bicket Street, Huntington Park, Calif.

Pumps—The Jetflo Deepwell Pump is the topic of discussion in Bulletin W-321-M3A, giving the principal features, operation, rating and prices. Worthington Pump & Machinery Corp., Harrison, N. J.

Compressors — Bulletin 184 illustrates and describes air cushion valve compressors of the single stage-horizontal roller bearing type, motor driven. The bulletin gives a complete description of the parts that are used in the compressors and each part is illustrated. A double page sectional view of the compressor is included showing the general makeup of the equipment. Pennsylvania Pump & Compressor Co., Easton, Pa.

Compressor — Feather valve compressors of the single cylinder, single stage type and either motor driven or steam driven are illustrated and described in Bulletin L-611-B8. Worthington Pump & Machinery Corp., Harrison, N. J.

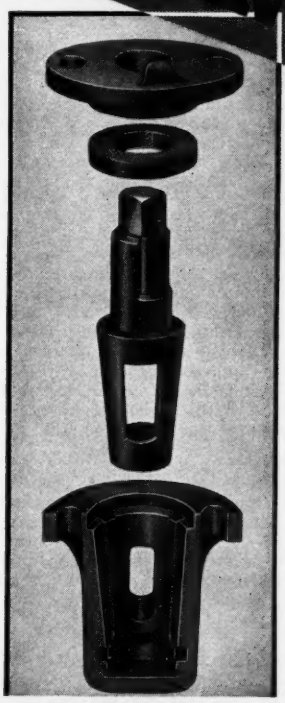
Modern Equipment for Power Plant is the subject of new 8-page bulletin, form 2536, illustrating such diverse types of equipment as pumps, compressors, condensers, ejectors, blowers, receivers and aftercoolers; also hoists, pneumatic tools and rock drills for maintenance and construction work. Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

Heating Specialties

Steam Specialties—Bulletin 439 illustrated and describes in detail industrial steam traps, giving capacity, size, price and application of each type. Welded floats are treated in Bulletin 339. W. H. Nicholson & Co., 12 Oregon St., Wilkes-Barre, Pa.

ASBESTOS-PACKED COCKS

BRONZE • HIGH TEST CAST IRON • NI-RESIST IRON



A READING-PRATT & CADY ASBESTOS GROOVE PACKED COCK

No metal to metal contact between plug and body. Pressed-in grooves of vulcanized asbestos minimize friction and provide tight contact at all temperatures. Asbestos ring for top adjustment . . . Sizes begin at ⅛". Two-way and three-way types. Pressures: 125 pound, 150 pound, 250 pound . . . Bronze, High-test iron, NI-Resist (high nickel alloy) iron and Cast Steel.

GIVE credit to operators of steam, refrigeration, compressed air, textile and alkali plants—to paper mills, die houses, soap makers, refiners of petroleum products—to plants where liquids carry solids in suspension—to hundreds of other industries and men . . . give credit to these for working with us in developing Reading-Pratt & Cady Asbestos Packed Cocks to their present place of service to industry.

56 years have passed since this organization first introduced cocks of this type to America. Today they solve many problems where globe, angle or gate valves fail, and where ground plug cocks are not satisfactory for the industries named above. They also are suited exactly to boiler service where we recommend their use for boiler blow-off, water column blow-off, between check and boiler, and between water column and boiler.

Ask your Jobber or write to us direct for recommendations for applying these valves to your service.

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BRASS AND IRON VALVES • STEEL VALVES • FITTINGS

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AMERICAN CHAIN DIVISION • AMERICAN CABLE DIVISION • ANDREW C. CAMPBELL DIVISION • FORD CHAIN BLOCK DIVISION • HAZARD WIRE ROPE DIVISION • HIGHLAND IRON AND STEEL DIVISION • MANLEY MANUFACTURING DIVISION • OWEN SILENT SPRING COMPANY, INC. • PAGE STEEL AND WIRE DIVISION • READING-PRATT & CADY DIVISION • READING STEEL CASTING DIVISION • WRIGHT MANUFACTURING DIVISION • IN CANADA: DOMINION CHAIN COMPANY, LTD. • IN ENGLAND: BRITISH WIRE PRODUCTS, LTD. • THE PARSONS CHAIN COMPANY, LTD. • *In Business for Your Safety*

Boilers and Prime Movers

Boilers—Five new bulletins on various types of boilers have just been issued, giving a description and specifications of each type. The types that are covered are: the Series S, Three Pass Boilers, Stoker Unit Boilers, Type T, Hand Fired Boilers, Type W, Electric Welded Smokeless Boilers, Cross Drum Water Tube Boilers and Long Drum Water Tube Boilers. Oil City Tank & Boiler Co., Oil City, Pa.

Steam Turbines—To serve as a comprehensive application guide on steam turbines in sizes up to 10,000 kw., Westinghouse Electric & Mfg. Co. has just issued a new 48-page "Economical Power." This shows seven principal types of turbines, typical installations with cross-sectional views, structural details of the turbines themselves and lubricating systems, governors and other control equipment. Copies of Bulletin 2198 may be obtained from department 7-N-20PE. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Diesel Tractor — The outstanding mechanical features of the 61-hp. Caterpillar Diesel D7 Tractor are shown in a new booklet, Form 5330. Particular emphasis is placed on the four-cylinder Diesel engine that powers the machine. The tractor transmission and the tracks are given a separate section of the book. Caterpillar Tractor Co., Peoria, Ill.

Diesel Engine—Bulletin S-500-B5E illustrates and describes the vertical four cycle direct injection Diesel engine. The bulletin includes principal features and specifications. Worthington Pump & Machinery Corp., Harrison, N. J.

Water Treatment

Conditioning Water for the Paper Mill—Copy of a talk presented with slides by Eskel Nordell before a gathering at the Southern Paper Festival in Savannah has just been printed by and may be had on request to The Permutit Co., 330 W. 42nd St., New York, N. Y.

Water Treatment—Bulletin 286 discusses Nalco No. 8, an anti-incrustant or scale retarder to be used for stabilized water. The use of Nalco No. 21 to eliminate algae and slime is the subject of Bulletin 31. National Aluminate Corp., 6216 West 66th Place, Chicago, Ill.

Water Softeners—Permutit portable water softeners are illustrated and described in Bulletin 2215 giving the operating principle and specifications. The Permutit Co., 330 West 42nd St., New York, N. Y.

Water Softener — Publication 2860 gives a complete treatise on water treatment and application of the Cochrane Zeolite Softeners. The zeolite softener process is discussed in detail. The zeolite softener is illustrated and described and three case studies are given to show how to determine just what equipment is needed. The bulletin also includes tables of price list, capacities and dimensions of the different size softeners. Cochrane Corp., Philadelphia, Pa.

Zeolite Water Softening—The simplicity of removing hardness from a water supply by Zeolite softening, supplemented by data on the methods of mining, processing, manufacture and use of Permutit Zeolites is covered in a new 32 page booklet, Bulletin No. 597 just issued by The Permutit Co., 330 W. 42nd St., New York, N. Y.

Materials

Cement — A revised and enlarged edition of the Smooth-On Handbook describes all Smooth-On Metal Cements and products.—Smooth-On Mfg. Co.

Insulcrete—A light weight insulating refractory concrete used for direct exposure to flame and furnace gases up to 2500 deg. F. is illustrated and described in a new 4-page bulletin recently issued by the Quigley Co., Inc., 56 West 45th St., New York, N. Y.

Refractories—This booklet shows the trend toward thorough education of the user and is intended to help him in making careful selection of refractories. Actual, natural color reproductions, made directly from the brick, show exactly what happens—the important changes that occur—in the brick when heated to service temperatures. A. P. Green Fire Brick Co., Mexico, Mo.

Engineering Literature

Directory of Chemical Engineers—The fifth edition of the Directory of Association Members, January, 1939, has just been published. This directory is designed to help all who need chemical advice or service. Members are listed, giving their qualifications and the kind of service they are prepared to render. Association of Consulting Chemists and Chemical Engineers, Inc., 50 East 41st St., New York, N. Y.

American Standards and Safety Codes—The new annual list of American Standards and Safety Codes includes 400 nationally approved standards, safety codes, and specifications indexed alphabetically and also industrially according to subject. The list may be obtained free of charge from the American Standards Association, 29 West 39 Street, New York, N. Y.

First Supplement of the Fourth Annual Edition of 1939 Shows and Exhibits has been released by the Exhibitors Advisory Council, Inc., 120 Greenwich Street, New York city, giving names national, regional, state and local shows scheduled for 1939. A limited number of these Supplements have been set aside for non-membership distribution and may be purchased at $2 per copy.

Technical Books — A new 36-page catalog of technical books has just been issued covering domestic and imported books on chemistry, physics, mathematics, medicine, metallurgy, machinery, engineering, biology, general science, business, manufacturing, formularies and technical dictionaries. A copy will be sent to anyone interested on receipt of stamps to cover postage. Chemical Publishing Co., Inc., New York, N. Y.

Machine Tools For You is the title of a reprint of an address given by Howard W. Dunbar. It discusses such topics as Mass Production, What Is a Machine Tool? and gives a general discussion of the entire industry in topics taken individually. National Machine Tool Builders Association, 10525 Carnegie Ave., Cleveland, Ohio.

Valves and Piping

Revolving Joints—Bulletin 291 illustrates and describes Barco revolving type flexible ball joints which are used to supply steam, gas or other fluids from a fixed or stationary pipe to a rotating drum. Barco Mfg. Co., 1801-1915 Winnemac Ave., Chicago, Ill.

Piping—A revised 6-page, two-color Bulletin No. 35-70B illustrates and describes ADSCO pipe supports, saddle plates, pipe alignment guides and pipe anchors for steam or hot water lines. American District Steam Co., North Tonawanda, N. Y.

Seamless Flexible Metal Tubing—A new 24-page catalog illustrated with pictures and charts contains complete discussions on the proper use of the product for conveying steam, liquids, gases; controlling vibration, connecting misaligned and moving parts, and the part that Seamless plays in product design. There are also complete engineering data and specifications with simple installation rules. American Metal Hose Branch of the American Brass Co., Waterbury, Conn.

Valves—A booklet entitled Service Characteristics of Globe Valves and Gate Valves is designed to help the user select the proper valve for his particular service. Two charts have been inserted to assist in this purpose. Crane Co., Chicago, Ill.

Air Conditioning

The Story of Air Conditioning—A new 12-page booklet under this title is illustrated in the Disney cartoon style, with four hypothetical characters—Tempy, Drippy, Dusty, and Stirry—personifying temperature, humidity, cleanliness, and air motion, respectively, the four elements to be controlled in air conditioning. Air Conditioning Manufacturers' Assn., Southern Bldg., Washington, D. C.

Fans—Bulletin F-7 gives a complete listing of Wing-Scruplex Propeller Fans with capacities and other data, including also acid-resisting and dyehouse fans, shutters and penthouses L. J. Wing Mfg. Co., 154 West 14th St., New York, N. Y.

Axiflo Pressure Fans—B. F. Sturtevant Co. A 20-page Catalog 444 giving the construction, applications and performance features of the products. A capacity table for each size fan is included in the catalog.

Steam costs per 1000 lbs.: hand-firing . . . 35.0c
" " " " " : Iron Fireman fired 20.8c
Iron Fireman Poweram saves 14.2c

IRON FIREMAN POWERAM STOKERS pay for themselves every 59 weeks

. . . reports Patterson Mills, Roanoke Rapids, N. C.

The Patterson Mills previously hand-fired its three boilers at a fuel cost per thousand pounds of steam of 35 cents. Iron Fireman *Poweram* firing reduced this cost to 20.8 cents. Further, Iron Fireman has lowered labor expense. Fuel and labor savings every year amount to 87% of the original cost of installing Iron Fireman, which means that this equipment pays its original cost every 59 weeks.

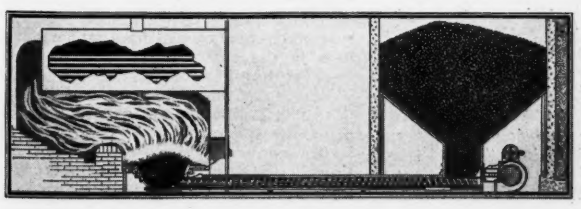
Besides this astounding economy Patterson Mills now has greatly improved steam control and is able to maintain much more constant steam pressure to meet the requirements of its processing load.

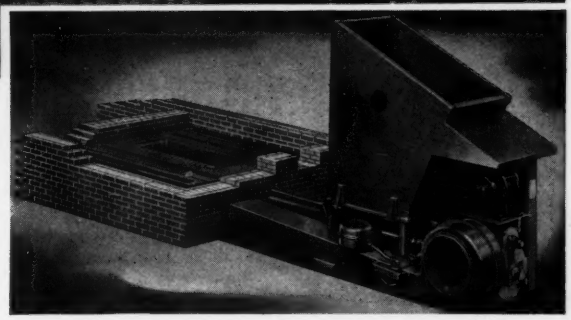
These fuel and labor savings are the equivalent of a return, on each $1000 invested, of $870 *every year!*

The three Iron Fireman *Poweram* stokers installed in the Patterson Mills boiler room are paying for themselves every 59 weeks!

"*Naturally* we are pleased," says F. C. Williams, vice-president and manager of the Patterson Mills Company, Inc.

NO COAL-HANDLING. Iron Fireman stokers are made in both hopper and bunker-feed models, the latter eliminating manual coal handling. In the illustration below, note the simplicity of the *Poweram* bunker-feed installation. With other models of Iron Fireman commercial-industrial stokers, the conveying section is installed directly on the floor of the bunker . . . no special bunker construction required.





Above: The Patterson Mills, at Roanoke Rapids, N. C. *Below:* The Iron Fireman *Poweram*, the famous power stoker which combines the advantages of efficient, easy-flow screw feed, and ram distribution for even fuel bed.

Poweram Stokers have screw feed and ram distribution

The Iron Fireman Poweram brings new high efficiency to automatic coal firing. With all flights of the feed worm acting on the coal at all times, the fuel does not pack . . . it arrives at the retort in an easily-aerated condition. The reciprocating ram blocks distribute the coal evenly within the retort, creating a uniform firebed under both heavy and light loads.

An engineering survey for the asking

What are your potential fuel savings with Iron Fireman firing? What improvements will Iron Fireman make in maintenance of steam pressure? These questions will be answered in a report on your boiler plant, which an Iron Fireman engineer is ready to prepare for you in cooperation with your own engineer, fireman or consulting engineer. No obligation. See your local Iron Fireman representative or send coupon. Available on convenient payment plan. Factories in Portland, Ore.; Cleveland, Ohio; Toronto, Canada.

IRON FIREMAN

AUTOMATIC COAL STOKERS

IRON FIREMAN MANUFACTURING CO.
3213 W. 106th Street, Cleveland, Ohio

☐ Make firing survey
☐ Send catalog

Type of Plant
☐ Power
☐ Commercial heating

Name_____

Address_____

Wing Featherweight Unit Heaters is the title of Bulletin H-6AB, giving engineering data, heater capacities, construction details and other information. L. J. Wing Mfg. Co., 154 West 14th St., New York, N. Y.

Heating Coils—Featherfin Heater Sections, described in the new 8-page Bulletin HS-1, are of finned-copper tube design through which air is forced. Inside the tubes is circulated steam or hot water for heating, or cold water or refrigerant for cooling. The bulletin explains the uses and construction of two general types, the standard type and the safe-against-freezing V-T type which allows close control of the delivered air temperature without throttling of steam. L. J. Wing Mfg. Co., 154 W. 14th St., New York, N. Y.

Miscellaneous

Eye Protection—An illustrated 8-page Bulletin No. CE-8 on M.S.A. eye protection for every job in industry has just been published, describing a complete line of goggles and spectacles, welding helmets and shields, combination protective hats with welding shields or goggles and several additional new items. Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh, Pa.

Bolt Dies—A new pamphlet illustrates and describes the new adjustable bolt die stock. The Toledo Pipe Threading Machine Co., Toledo, Ohio.

New Engineering Books

How to Make Alignment Charts.—By Merrill G. Van Voorhis. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd Street, New York city. Size 6 by 9 in.; 114 pp.; cloth bound. Price $2.50.

The title of this book is an excellent description of its contents, for it is fundamentally a practical "how" book showing the construction used in making nomographic or alignment charts for the solution of engineering and other formulas. The different charts are taken up one by one, each step in the construction is explained in detail by means of an example. In addition an index of general equation forms in the front of the book makes it possible to locate the solution of any particular type of equation at a glance. For those interested in the fundamental theory upon which the chart construction is based, a short discussion is given in the Appendix. Alignment charts, although by no means a new method for solving equations graphically, are, because of their simplicity of construction and use, coming into much more widespread use. This book aims to simplify the procedure of construction as much as possible by what the author characterizes as "recipe-like" so that a knowledge of the fundamental theory is not essential to its practical use.

Boilers, Superheaters, Economizers, Air Heaters and Piping 1938, has been published as Publication No. F15 by the Edison Electric Institute, 420 Lexington Ave., New York, N. Y. This is a report of the Prime Movers Committee and among other things includes a tabulation of boiler outages and a summary of practices of operating companies in the welding of piping for high-temperature high-pressure service. Price $1 to members; $2.50 to non-members; $2.65 in foreign countries.

How to Estimate for the Building Trades. By Gilbert Townsend, J. Ralph Dalzell, James McKinney and Carl H. Dunlap. Published by the American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. Size 5½ by 8½ in.; 604 pp., cloth bound. Price $4.75.

A complete and practical book on the estimating of materials and labor for every phase of the building trades. It is concerned primarily with residences and moderate sized buildings but the methods have universal application and cover not only all estimating processes but a complete explanation of the things a man needs to know to do a thorough job. Blueprint reading, with a set of 8 full-sized blueprints complete in detail and drawn to standard scale, and mathematics used by estimators, including a complete table of functions, are explained in full. It is a book for the experienced as well as the inexperienced man. It teaches how to do the actual work of the various trades and has over 500 questions with answers worked out in detail with references to the actual plans. Regulation estimating forms are also included.

Turbines, Condensers and Pumps 1938. Published by the Edison Electric Institute, 420 Lexington Ave., New York. N. Y. Size 6½ by 11 in., paper bound, 33 pp. Price $1.75 to non-members in the U. S. A.

This publication, No. F14, is the report of the Turbines Subcommittee of the Prime Movers Committee. It covers statements by operating companies, manufacturers and turbine operating data; new turbine installations: experiences; condensers, pumps and cooling towers.

Graphic Routes to Greater Profits. By John W. Esterline. Published by The Esterline-Angus Co., Indianapolis, Ind. Size 8½ by 11 in., 320 pp. Price $3.00.

Disclosing the modern technique of critical examination and diagnosis of industrial operations, this volume is a practical contribution to the art of applying the scientific method to the conduct of industry. It is a volume of experience rather than opinion. There are more than 250 case studies, each covering a distinct problem, giving the procedure followed, the graphic charts obtained and the solution reached.

The introductory section comprises 30 pages and is divided into three chapters, under the captions: The High Cost of Inefficiency; What Graphical Representation Means and Classification of Industrial Problems. The remainder of the book is in five divisions—The Problems of Power; The Problems of Machines; The Problems of Processes; The Problems of Men; Research and Special Problems. The case studies throughout the 19 chapters are numbered serially, and are carefully cross-indexed. For its practical value as a book of instruction and reference, and as a means of inducing a realistic, scientific approach to the every-day problems of industry, executives and engineers will find this volume of real interest and value.

Creep Data, compiled by the Joint A.S.M.E.—A.S.T.M. Research Committee on the Effect of Temperature on the Properties of Metals, is a volume of 864 pp. with important data on high-temperature creep characteristics of metals and alloys. The 486 sheets of test data, 273 graphs and 37 tables cover wrought steels and ferrous alloys, cast steels and ferrous alloys and non-ferrous materials.

Copies of this publication can be obtained from either Society, A.S.T.M., 260 S. Broad St., Philadelphia, Pa., or A.S.M.E., 29 West 39th St., New York city, at $12 each postpaid in the U. S. and Canada; other countries, $14.

The Engineers' Manual—By Ralph G. Hudson, Published by John Wiley & Sons, Inc., New York, N. Y. 340 pages; size 5 by 7¾ in. Price $2.75.

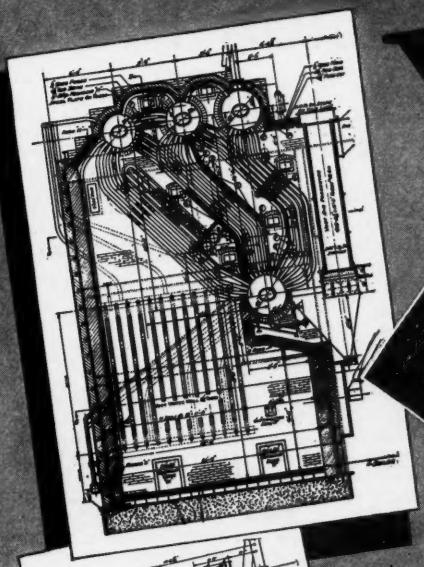
Formulas and constants which are generally used by the practicing engineer and engineering student are conveniently assembled in this new edition of the Engineers' Manual. Preceding each formula is a statement clarifying its application the symbology of the involved physical quantities and definite units of measurement. In this second edition the entire chapter on heat and a large part of the chapter on electricity have been rewritten and brought up to date. Professor C. F. Svenson and A. E. Fitzgerald assisted the author in this work.

This edition also contains revision and extensions of all tables of physical constants, new steam tables, recomputations of all conversion factors affected by the latest definition of B.t.u. and enlarged table of conversion factors and many additions throughout the book.

Practical Heat. By Terrell Croft, second edition. Revised by R. B. Purdy. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York City. Size 5 by 8 in.; 682 pp.; cloth bound. Price $5.00.

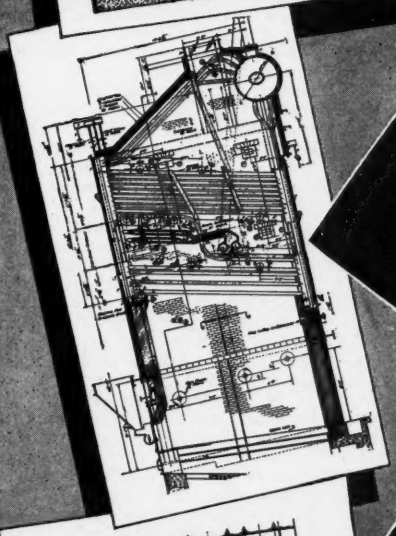
The contents of this book live up to its title. It is fundamentally a book on heat and the practical application of heat presented in such a way that it may be followed by those with only a working knowledge of arithmetic. It has been planned on the basis that the application of heat to power plant work cannot be understood unless one is familiar with the basic fundamentals of the subject so the first fourteen divisions are devoted to this phase. The remainder deals with the application of heat in the entire steam power plant, internal combustion engines, building warming, refrigeration, application and use of instruments. Application of the principles presented are shown by a large number of problems and questions, solutions to these problems being given in a 20 pp. appendix.

Vogt



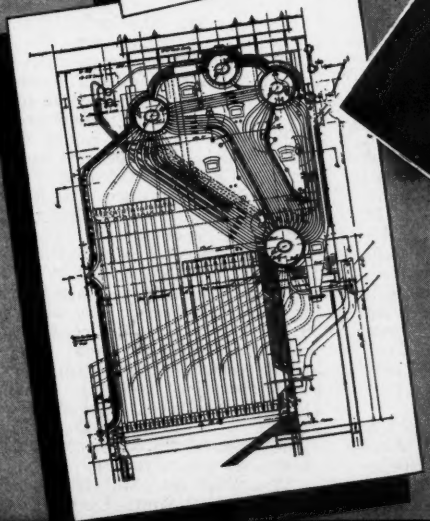
KIMBLE GLASS COMPANY, VINELAND, N. J.
30,000 lbs. steam per hour Vogt LE type bent tube Unit. Furnace arranged for pulverized fuel. Front and side water wall tubes. Vogt Air Preheater. Design pressure 175 lbs.—Total steam temperature 490 degrees F.

Water Tube



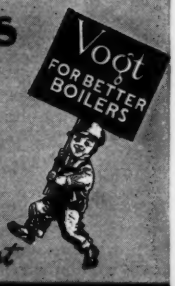
IN A LARGE MID-WESTERN POWER PLANT.
80,000 lbs. steam per hour Vogt sectional header type Unit. Spreader stoker using lignite. Present operating pressure 225 lbs.—Total steam temperature 522 degrees F. Design pressure 400 lbs. — Total steam temperature 700 degrees F.

BOILERS



CLEVELAND WORSTED MILLS CO., CLEVELAND, O.
90,000 lbs. steam per hour Vogt M type bent tube Unit. Pulverized fuel. Water wall tubes. Present operating pressure 150 lbs.—Total steam temperature 515 degrees F. Design pressure 616 lbs. — Total steam temperature 750 degrees F.

BENT TUBE SECTIONAL HEADER AND BOX HEADER TYPES
For Any Fuel



Bulletins on Request

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Power Plant Construction News

Calif., Burbank—Cleveland Pneumatic Tool Co., 3734 Seventy-eighth Street, Cleveland, Ohio, plans installation of electric power equipment in new branch plant at San Fernando Road and Hollywood Way, Burbank, where tract of about 10 acres of land has been acquired. It will consist of three one-story structures. Entire project will cost about $200,000.

Calif., Pasadena—Municipal Light and Power Department plans new cooling towers at municipal electric generating station on East Glenarm Street. New units will be about 200 ft. high and estimated to cost close to $70,000. Proposed to carry out work this summer. Benjamin F. DeLanty is general manager.

Calif., San Diego—Ryan Aeronautical Co., San Diego, plans installation of electric power equipment in new aircraft-manufacturing plant, one-story, 200x275 ft., in vicinity of local U. S. Coast Guard air base. Erection is scheduled to begin soon. Cost about $100,000. Edward C. and Ellis W. Taylor, 803 West Third Street, Los Angeles, Calif., are architects.

Conn., Meriden — Chandler-Evans Corporation, 2200 Eighth Street, Detroit, Mich., manufacturer of aircraft and automobile engine equipment and parts, plans installation of electric power equipment in new branch plant, 100x145 ft., near Martin airport, Meriden, where site recently was acquired. Work will begin soon. Entire project will cost over $85,000.

Fla., Miami—Growers' Cold Storage Corporation, 1200 North Twenty-second Street, has plans maturing for new cold storage and refrigerating plant, 80x150 ft. Cost reported about $50,000, with machinery. Proposed to carry out project during summer. Pfeiffer & Pitt, First Avenue, S. E., are architects.

Ill., Chicago—Arrow Match Co., 3033 West Grand Avenue, plans installation of power equipment in new plant on tract of land at North Avenue and First Street, Proviso Township, near Chicago, recently acquired, to consist of a group of eight one- and two-story buildings. Entire project estimated to cost about $150,000.

Ind., Fort Wayne—Acme Engineering Service, Inc., Old First Bank Building, Fort Wayne, has secured an extension to license to construct and operate a hydroelectric power plant on Salamonie River, near Lagro, Wells County, until December, 1939. Plans are scheduled to be completed soon, with work to proceed in fall. Entire project is reported to cost over $650,000, with transmission lines. Caldwell Engineering Co., Jacksonville, Ill., is consulting engineer.

Iowa, Des Moines—Board of Education plans new boiler plant at East high school, East Thirteenth and Maple Streets, for central-heating service, with installation of boiler unit and auxiliary equipment. Proudfoot, Rawson, Brooks & Borge, Hubbell Building, are architects. A. W. Merrill is school superintendent.

Iowa, Woodbine—At recent special election, citizens have approved bond issue for new municipal electric power plant in amount of $115,000, and plans are scheduled to be prepared at early date. Proposed to use Diesel engine-generator units.

Kan., Osborne—City Council plans expansion and improvements in municipal electric power plant, including installation of additional equipment. Estimates of cost are being made. S. J. Schwamp, mayor, in charge.

Kan., Wathena — Wathena Apple Growers' Association, Taylor M. Bower, manager, plans early erection of new one-story cold storage and refrigerating plant, 70x100 ft. Cost reported close to $40,000, with equipment.

Md., Baltimore—Consolidated Gas, Electric Light & Power Co., Lexington Building, has filed plans for additions to steam-electric generating station at Westport, comprising extension in steam division, 81x103 ft., and 125 ft. high; and turbine room enlargement, 64x103 ft., and 77 ft. high. Capacity of plant will be increased with installation of new turbo-generator unit, high-pressure boilers and accessory equipment. Entire project will cost over $3,000,000, and is scheduled for completion early next year.

Md., Belcamp—Bata Shoe Co., 2704 West North Avenue, Chicago, Ill., plans power house for factory service at new plant at Belcamp, where company has tract of about 2000 acres of land. It will comprise several buildings, with main five-story unit. A housing development will be carried out for employes at plant. Entire project will cost over $750,000. Work is scheduled to begin soon.

Mo., North Kansas City — Corn Products Refining Co., 333 North Michigan Avenue, Chicago, Ill., plans installation of electric power equipment in new additions to branch mill at Bedford and Tenth Streets, North Kansas City. Entire project is reported to cost in excess of $150,000. N. M. McKenzie, first noted address, is company engineer.

N. Y., Fredonia—State Department of Education, Education Building, Albany, N. Y., has plans nearing completion for new power house at state school at Fredonia. Bids will be asked soon. Cost reported over $100,000, with boiler units and auxiliary equipment. W. E. Haugaard is commissioner of architecture, State Office Building, Albany, in charge; T. F. Farrell, same address, is engineer.

N. Y., New York—Consolidated Edison Co. of New York, Inc., 4 Irving Place, plans early conversion of large part of steam-generating stations from coal to oil fuel, and will install new equipment and facilities for this purpose.

N. Y., Syracuse—Crucible Steel Co. of America, Inc., 405 Lexington Avenue, New York, N. Y., plans installation of electric power equipment in connection with expansion and improvements in branch mills at Syracuse, operated as Sanderson Brothers Steel Works and Halcomb Steel Co., divisions. Work will be carried out during summer. Entire project reported to cost over $400,000.

Ohio, Cleveland—Hankins Container Co., 3044 West 106th Street, plans installation of electric power equipment in new two-story addition to fiber box and container-manufacturing plant. Work will be placed under way soon. Entire project will cost close to $100,000. Edward R. Hankins is president.

Pa., Philadelphia—Barrett Co., Margaret and Bermuda Streets, manufacturer of coal tar products, chemicals, etc., plans installation of electric power equipment in new addition to chemical plant in Frankford district for production of synthetic phenol and allied specialties. Entire project is reported to cost over $300,000. Company is a subsidiary of Allied Dye & Chemical Corporation, 61 Broadway, New York, N. Y.

Texas, Houston—Pittsburgh Plate Glass Co., Grant Building, Pittsburgh, Pa., plans installation of electric power equipment in new factory branch, storage and distributing plant to occupy part of a 19-acre tract of land recently acquired in Burchfield industrial district, Houston. Cost about $150,000. At later date company proposes to build a branch glass-manufacturing plant at same location, to represent ultimate investment over $750,000.

Va., Christiansburg — Southern Dairies, Inc., 60 M Street, N. E., Washington, D. C., plans installation of electric power equipment in new milk-processing plant at Cambria, near Christiansburg, to replace a unit recently destroyed by fire. Work will begin soon. Entire project will cost about $100,000.

W. Va., Marlinton—Peerless Coal & Iron Co., Capital City Building, Charleston, W. Va., plans installation of power equipment at new coal-mining plant on tract of land in vicinity of Marlinton. A power house is proposed. Bids will be asked soon. Entire project reported to cost over $85,000. Rush Meadows is company engineer in charge.

W. Va., Nitro—American Viscose Corporation, 200 Madison Avenue, New York, N. Y., plans installation of electric power equipment in new group of buildings at cellulose rayon mill at Nitro, for shop and general operating service. Cost reported over $100,000. Work will begin at once. The Ballinger Co., 105 South Twelfth Street, Philadelphia, Pa., is engineer.

Wis., Genoa—Tri-State Power Cooperative, Inc., Platteville, Wis., E. J. Stoneham, manager, will take bids soon for new steam-electric generating plant on site near Genoa. Also for power substations, primary and secondary lines for rural electric system, and complete operating facilities. Fund of $1,500,000 has been arranged for entire project. A. Y. Taylor & Co., 8025 Forsythe Boulevard, Clayton, Mo., are engineers for power station.

Wis., Superior—Stokely Brothers & Co., Inc., 2002 South East Street, Indianapolis, Ind., plans installation of electric power equipment in connection with proposed rebuilding of branch food-canning plant at Superior, recently destroyed by fire. Loss estimated close to $400,000.